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BRITISH COLUMBIA
DEPARTMENT OF MINES

HON. WM. SLOAN, Minister.
R. F. TOLMIE, Deputy Minister. W. FLEET ROBERTSON, Provincial Mineralogist.
THOMAS GRAHAM, Chief Inspector of Mines.

BUREAU OF MINES REPORT
ON
IRON-ORE DEPOSITS
OF
VANCOUVER AND TEXADA ISLANDS

BULLETIN No. 3, 1917

BY
W. M. BREWER, M.E.



THE GOVERNMENT OF
THE PROVINCE OF BRITISH COLUMBIA

VICTORIA, B.C.:
Printed by WILLIAM H. CULLIN, Printer to the King's Most Excellent Majesty.
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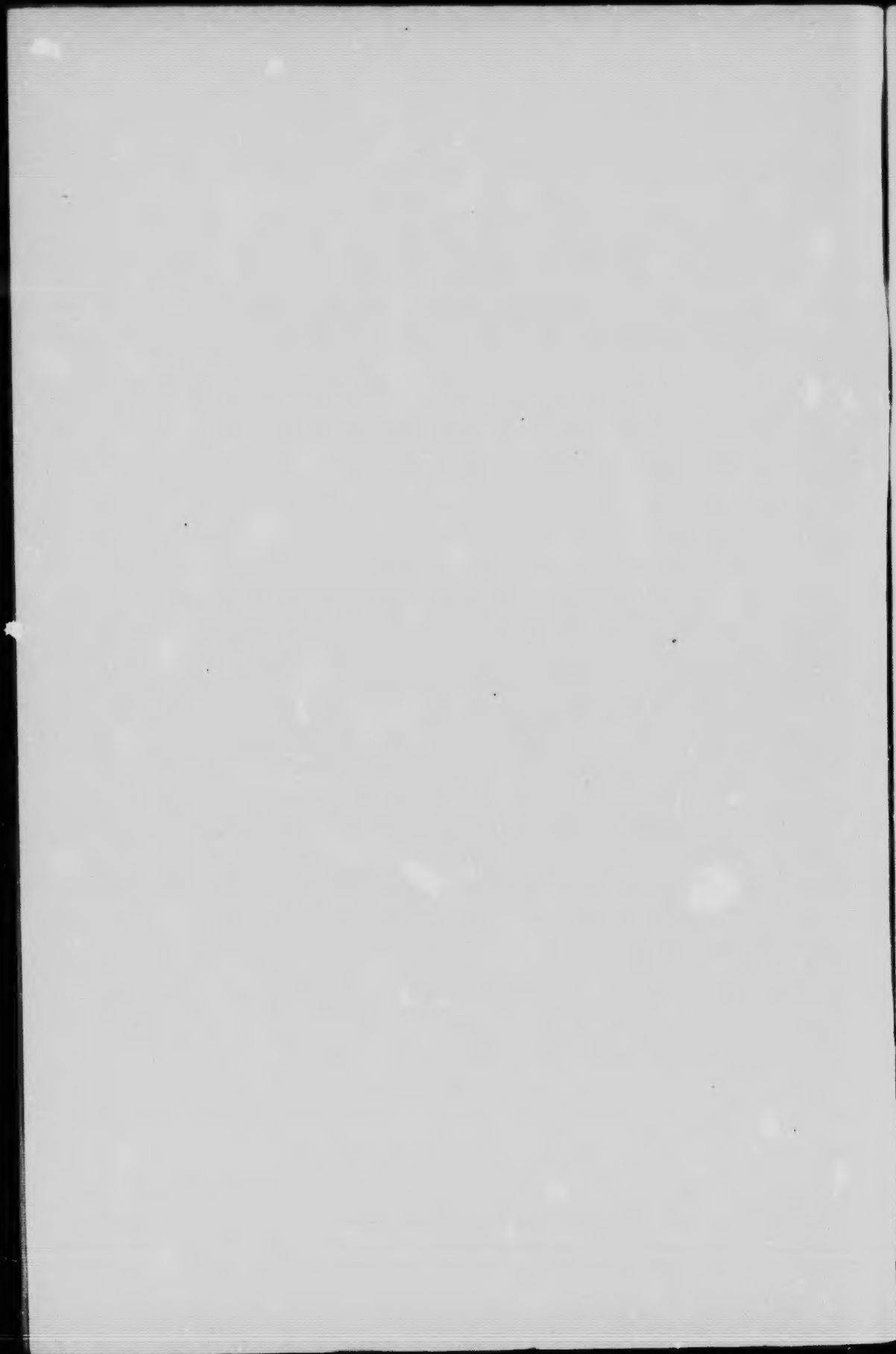
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*To the Hon. William Sloan,
Minister of Mines, British Columbia.*

SIR,—I have the honour to submit herewith a Preliminary Report on some of the occurrences of Iron-ore Deposits on Vancouver and Texada Islands, by W. M. Brewer, M.E., prepared this season under instructions for the Bureau of Mines.

I have the honour to be,

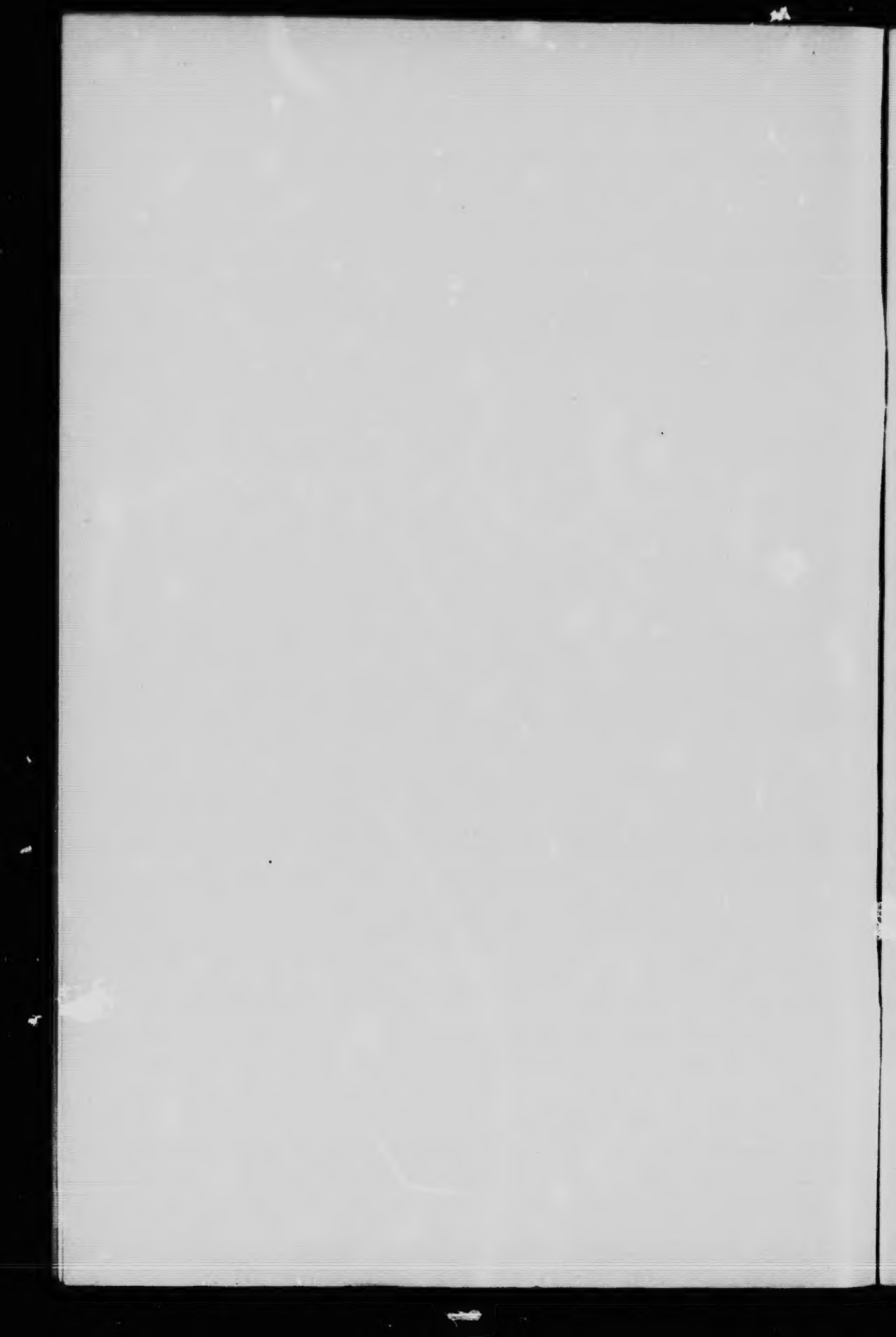
Sir,

Your obedient servant,

WILLIAM FLEET ROBERTSON,

Provincial Mineralogist.

*Bureau of Mines, Victoria, B.C.,
February, 1917.*



Report on the Occurrences of Iron-ore Deposits on Vancouver and Texada Islands, B.C.

BY WM. M. BREWER, M.E.

OUTLINE OF REPORT.



THE following report is made after an examination by the writer of the various occurrences of iron ore on Vancouver and Texada Islands during the summer of 1916, in compliance with instructions from the Provincial Mining Department. The most important deposits of iron ore occur at several points along the west coast of Vancouver Island, also at points near the east coast; and on the west coast of Texada Island, in the strait of Georgia.

The most notable points along the west coast of Vancouver Island where such deposits occur are the Gordon river, Bugaboo creek, Barkley sound, Alberni canal, Henderson lake, Kennedy lake, and Nootka and Quatsino sounds. Near the east coast of Vancouver Island deposits are found on the Upper Quinsam lake and on Klaskan river. On the west coast of Texada Island the deposits occur between three and four miles north of Gillies bay.

Magnetite is the most usual iron ore occurring at the several points referred to. This ore is usually found at or near the contact between crystalline limestone and eruptive rocks belonging to the Vancouver series, as classified by the late Dr. Dawson. The percentage of iron carried by the ore is usually between 55 and 70 per cent., with the percentage of phosphorus quite low and generally considerably below the "Bessemer" limit.

In some of the deposits the content of sulphur is more than 1 per cent., but usually it is less than that. The higher sulphur content is accounted for by the fact that there is sometimes a variable quantity of pyrrhotite and iron pyrites more or less closely associated with the magnetite, and generally when this is the case some of the ore also carries a low percentage of copper.

In many cases the magnetite-deposits have been found to carry a percentage of copper sufficiently high to cause such deposit to possess a greater commercial value for the copper content, and therefore no value for iron-making. Many of the occurrences of copper ore on the islands referred to are closely associated with magnetite, and such ore is sometimes attractive to smelters on account of the fluxing qualities. None of such occurrences of copper ore are described in this report, which is confined to a description of such deposits only as apparently possess commercial value as iron-ore mines for the production of pig-iron.

The percentage of insoluble matter, chiefly silica, contained in a number of samples varies appreciably, ranging from less than 3 to 26 per cent.

Limonite, or bog-iron ore, occurs on the west coast of Vancouver Island, near its north end, on the West arm of Quatsino sound.

Hamatite has been reported to occur on the islands referred to in this report, but the writer failed to find any deposits of this variety of iron ore during his examinations.

Tonnage.—From the writer's observations and examinations of the surface showings and the development-work on the various mineral claims examined by

him for iron ore during 1910, he concludes that, so far as quantity of ore available for mining is concerned, it is only possible to make a very rough estimate. Under the present conditions even that estimate can only be made on theory, and much more development must be done to prove the figures, which may be considerably increased, given in the following report. The development-work is not sufficient in any instance to determine the conditions beyond a shallow depth, as regards the continuity of the magnetite-deposits to deep levels. The same statement applies to the question of the superficial extent, because except in a few cases the boundaries of the deposits are not exposed. It is evident that in several instances the workings underground show that the ore-body is still strong at the lowest level reached, but that is only a shallow depth.

The writer has attempted to make an estimate of tonnage of ore available by dividing it into three classes, as follows:—

(1.) *Actual ore*, meaning thereby such quantity as development has exposed sufficiently to be considered as measurable and immediately available.

(2.) *Probable ore*, meaning such ore as is only partially developed, not sufficiently so to admit of definite measurement, but of the occurrence of which the indications are sufficiently strong to warrant an assumption that such ore probably occurs.

(3.) *Possible ore*, meaning such ore as is undeveloped, but which may possibly and is hoped to be found by further prospecting and development, the only indications of which are surface outcrops, and which may be postulated as possible from a knowledge of the geological conditions.

Name of Property.	Actual Ore.	Probable Ore.	Possible Ore.	Total.
	Tons.	Tons.	Tons.	Tons.
Ralph*	...	...	...	...
Rose*	...	...	...	...
Baden Powell and Little Bobs ..	...	500,000	250,000	750,000
Sirdar	94,000	...	47,000	141,000
Conqueror	16,000	230,000	120,000	306,000
Sarita (Provincial Mineralogist's estimate)	...	30,000	25,000	55,000
Henderson Lake	20,000	...	280,000	300,000
Black Prince	15,000	...	15,000	30,000
Crown Prince	75,000	...	200,000	275,000
Glengarry and Stormont (Nootka sound)	250,000	250,000	750,000	1,250,000
Fido (Nootka sound)	...	50,000	200,000	250,000
Quinsam Lake Iron Syndicate ..	...	...	5,000,000	5,000,000
Prescott (McConnell's estimate) ..	...	1,366,400	993,600	2,360,000
Paxton (McConnell's estimate) ..	...	1,607,200	...	1,607,200
Lake (McConnell's estimate) ..	...	504,000	...	504,000
Klaanch River*	...	...	...	...
Totals	470,000	4,537,600	7,880,600	12,888,200

NOTE.—Properties marked * are in such condition that no estimate can possibly be made of the tonnage available.

Prospecting with diamond-drills should be carried on quite extensively preparatory to the installation of any manufacturing plants.

INTRODUCTION.

The examinations made by the writer during the past season were undertaken principally for the purpose of bringing the information regarding the iron ores already in the possession of the Bureau of Mines up to date. During the past summer the writer was heavily handicapped, owing to the fact that because there has been no movement to create a demand for either iron-ore mines or the ore, the

prospectors and other owners of deposits that had been staked several years ago had suspended development-work after having acquired Crown grants for their claims. Owing to this fact the trails to the workings and outcroppings have been neglected; the underbrush, devil's-club, huckleberry, salmon-berry, and salal bushes have reached such great growth that the old trails were mostly found to be impassable, dumps of ore, as well as outcroppings, were covered up, and the entrances to tunnels were only found with great difficulty; consequently, considerably more time was occupied in making the examinations than otherwise would have been the case. In addition to such difficulties, the absence of the owners from most of the properties examined often presented such an obstacle as to seriously impede the work of examination.

BIBLIOGRAPHY.

The following mentioned reports have been published relative to the occurrences of iron ore on Vancouver and Texada islands:—

Report on the Iron Ores of the Coast of British Columbia, by Herbert Carmichael, published in the Minister of Mines' Report for 1902.

Bulletin on the Iron Ores of the Coast of British Columbia, by the Provincial Mineralogist, published in 1903.

Bulletin No. 47 on the Iron-ore Deposits of Vancouver and Texada Islands, British Columbia, by Elmar Lindeman, M.E., published by the Mines Branch, Canadian Department of Mines, in 1910, from examinations made in 1907.

Memoir No. 13, Southern Vancouver Island, by Chas. H. Clapp, published by the Canadian Geological Survey Branch, Department of Mines, in 1912, from examinations made in 1908, 1909, and 1910.

Memoir No. 58, Canada Department of Mines, Geological Survey, Texada Island, B.C., by R. G. McConnell.

In addition to the literature referred to, there have been several reports from examinations made by mining engineers for private clients previous to 1910 which have not been published.

HISTORY.

The history of the interest taken by the public in the iron-ore deposits on Vancouver and Texada islands dates back to 1874, when Messrs. Goodall, Perkins, and Prescott, of San Francisco, engaged W. H. Lee, a furnaceman from Alabama, to examine the deposits of magnetite on the west coast of Texada island, which that firm purchased the following year. The Puget Sound Iron Company was organized, which later erected a blast-furnace at Irondale, near Port Townsend, in the State of Washington, U.S.A., where the manufacture of charcoal pig-iron was started. The magnetite ore from Texada island was mixed with bog-ore from Hamilton, Skagit County, Washington.

At that time the San Francisco firm owned, in addition to the mines and blast-furnace, a fleet of steamers that plied between Puget Sound ports and San Francisco, also the manufacturing plant in San Francisco now owned by the Union Iron Works Company. Some years later all of these interests except the iron-ore mines were sold, but the last-named property was, and still is, retained by the original purchasers.

Until about 1907 considerable prospecting and some development-work was done in various portions of Vancouver island and at a few points on the mainland of British Columbia by various prospectors and companies in searching for other deposits of iron ore, but since then the interest has waned until the present time.

The most serious efforts to develop the iron industry on this portion of the Coast and utilize British Columbia ore were made by the late Homer Swaney, who was unfortunately drowned about 1904 in the wreck of the steamship "Challam," when he had practically carried his negotiations to the point where he was promised the necessary financial assistance to attempt to place the industry of iron and steel making on a commercial basis.

After the death of Mr. Swaney other attempts were made to establish the industry by using iron ore from Vancouver Island and smelting it in the State of Washington; the most notable by the Irondale Iron and Steel Company, which resulted in failure principally owing to commercial reasons.

No blast-furnace has yet been built in British Columbia, although the advisability of doing so has been very freely discussed.

GEOGRAPHY.

Considered geographically, the occurrence of deposits of iron ore are found to occupy positions, so far as the west coast of Vancouver Island is concerned, either immediately along the coast-line or a short distance back, usually not exceeding about ten miles. The deposits already known are found along an almost straight line in a north-west direction, conforming very closely with the general line of contact of the sedimentary deposits on the west with the general igneous batholith of the interior of the island. The most southerly deposit is situated almost directly on the coast-line south of the entrance to Sooke harbour, about thirty miles by auto-road west from the city of Victoria.

Travelling towards the north-west, the next known deposits of iron ore are near Port San Juan, on the Gordon river, also on Bugaboo creek, a tributary of that river. This location is about eighty miles by steamship route from Victoria.

Travelling still in a north-west direction, the next deposits of iron ore are adjacent to the Eastern channel of Barkley sound at the following locations, viz.: On the Sarita river, that empties into the sound in Numukamus bay; on Copper Island, about four miles north-west of the mouth of Sarita river; on the east side of Uchucklesit harbour, about a mile from the entrance; near the head of Henderson lake, about fourteen miles in a direction slightly west of north from the entrance to Uchucklesit harbour; at the head of Handy creek, that flows into Alberni canal, about two miles northward from the entrance to Uchucklesit harbour; also at Smith's Landing, about three miles farther up the canal on the east side.

There are two routes by which all of these deposits on Barkley sound can be reached; one is by railway over the Esquimalt & Nanaimo Railway to Port Alberni, the western terminus, thence by launch to the nearest landing to the deposit desired to be reached; the other route is by Canadian Pacific Railway steamer from Victoria direct, and as all of the occurrences of iron ore are within easy walking distance from the shore this route is very advantageous.

Continuing to travel in a north-westerly direction across Barkley sound from the Eastern channel to the Middle channel, several deposits of iron ore are found within a short distance from the shore at Sechart, which can be reached by either of the routes already mentioned.

The next occurrence of iron ore is near the head of Kennedy lake, and only about twelve miles in an air-line north-west from the head of Henderson lake. To reach Kennedy lake it is necessary, with the present facilities, to travel by steamer to Clayoquot sound, about twenty-five miles north-west from Barkley sound; thence by launch up Tofino Inlet, an arm of the sound, to the mouth of Kennedy river, and up that river into the lake, which is about twelve miles in length, to a point near the head, from which a trail has been built about three miles in length to the iron-ore deposits in the vicinity of Mount Maitland.

The next deposits of magnetite occur near the eastern and western shores of Hesquiat lake, at the head of Hesquiat harbour, situated about forty-eight miles in an air-line and north-westerly direction from Kennedy lake. Hesquiat harbour is reached by mail-steamer from Victoria twice each month under the present schedule.

From the last-mentioned location to the next known deposits of iron ore is a distance in a north-west direction, in an air-line, of about twenty-four miles, as they are located at the head of Head bay, on the Tlupana arm of Nootka sound. To reach

that point it is necessary to travel by steamer to the Indian village of Nootka, on Friendly cove, and take launch from there to the head of Head bay, a distance of about twenty miles, from which point there is a trail to the deposits, about one mile and a half in length.

The last mentioned is the most northerly deposit of magnetite on Vancouver island so far as at present known. There are deposits of bog-ore near the shore on the West arm of Quatsino sound.

There are two routes to Quatsino sound; one being by steamer from Victoria to Quatsino Landing, and by launch to the West arm, a distance of about ten miles; the other route being by steamer from Vancouver up the east coast of Vancouver island to Hardy bay, thence by trail across the island, a distance of about ten miles, to Coal harbour, on the West arm of the sound, distant about two miles from the iron-ore deposits. On the east side of Vancouver island deposits of iron ore, so far, have only been found in two localities; one on the Upper Quinsam lake, the other on the Kluanch river.

Upper Quinsam lake is situated about eighteen miles, in a straight line, from the village known as Campbell River, in a south-westerly direction, but by trail the distance is about twenty-five miles. The lake is the source of the Quinsam river, which is a tributary of the Campbell river, that flows into the strait of Georgia nearly opposite to Cape Mudge, the south end of Quadra island, distant about 120 miles in a north-westerly direction from the city of Vancouver. The occurrences of iron ore are reached by steamer from Vancouver to Campbell River Landing; thence by auto or wagon along the Strathcona Park highway seventeen miles to Gosseneck lake, where the main highway is left and a pack-trail followed for a distance of about five miles in a south-westerly direction to the north end of the Upper Quinsam lake; here a canoe is used to the south end of the lake, from which point a trail has been built for a distance of about half a mile to the mining camp.

The Kluanch River iron-ore deposits are situated about seven miles above the mouth of that river, which empties into the south-east end of Nimpkish lake, that drains through the Nimpkish river into Broughton strait at a point directly opposite to Alert bay. These deposits of iron ore are reached by steamer from Vancouver to Alert Bay Landing; thence by launch or canoe across Broughton strait to the property, a total distance from Alert bay of about twenty-seven miles, and from Vancouver of about 207 miles.

The Texada island iron-ore deposits are situated on the west side of that island about six miles from the north end, and about the same distance westerly from the village of Vananda, on the east coast, which is the port of call for all steamers plying between Vancouver and the island. Texada island is one of the largest islands situated between the mainland of British Columbia and Vancouver island in the strait of Georgia. Vananda is about seventy miles distant from Vancouver in a north-westerly direction. There is a good wagon-road connecting the village with the iron-ore deposits.

TOPOGRAPHY.

The following description of the topography of Vancouver island is copied from the report of Chas. H. Clapp, in Memoir No. 13, page 16, Geological Survey, Canada:—

"Vancouver island is a mountain range characterized by both flat-topped and ridge-like summits, and is the result of the mature dissection of an uplifted, subdued surface formed during a Tertiary erosion cycle acting on a heterogeneous group of deformed rocks. It lies to the west of the great marginal depression of North America, known as the Pacific Coast down-fold, and is one of the border ranges which characterize the western shore of the American continents. The Pacific Coast down-fold extends from the gulf of California to north of the Queen Charlotte islands. This down-fold is in part above sea-level in California, Oregon, and Wash-

ington, but both the southern and northern ends are submerged. The submerged northern end forms the sound region separating Vancouver island and the Queen Charlotte islands from the mainland. The down-fold is flanked on either side by great mountain ranges. Those on the east side are the Sierra Nevada of California, the Cascade range of Oregon and Washington, and the Coast range of British Columbia; those on the west are the Coast range of California, the Klamath mountains of Oregon, the Olympic mountains of Washington, the Vancouver range, and the low range of Queen Charlotte islands. The last two ranges have been grouped by Dawson and designated the Vancouver system. The Vancouver range constitutes virtually the entire island, which is 200 miles long and fifty to eighty miles wide, the total area being about 20,000 square miles.

"The Tertiary erosion surface, the general outlines of which are now preserved on the upland of Vancouver island, had reached before uplift a stage varying from late maturity to old age. It was peneplaned in the southern part where a few rounded, monadnock-like hills remained a few hundred feet above the general level. In the central region larger and higher monadnocks and small ranges of mountains—divide residuals—survived, which apparently had elevations of from 1,000 to 3,000 feet above the general Tertiary erosion level, and which are now from 5,000 to 7,000 feet above sea-level, a few peaks being higher. The elevation of the Tertiary peneplane is at present less than 1,500 feet near the southern coast, but increases rapidly to 2,000 feet, and then increases more slowly until the peneplane merges into the more rolling and mountainous country which, as mentioned above, is characteristic of the central part of the island."

The topography of the northern portion of Vancouver island is a continuation of the rolling and mountainous country described by Clapp as characteristic of the central portion, but towards the extreme north end the elevations of the mountain ranges decrease, the valleys become more extensive, and the peneplaned surface gradually loses elevation, until it is submerged into the sound region mentioned by Clapp as separating Vancouver island from the Queen Charlotte islands.

The deposits of iron ore usually occupy positions in the mountain ranges at elevations varying from sea-level, as is the case in the south end of the island, to nearly 3,000 feet above sea-level in the central and northern portions, except at Quatsino sound, where the bog-ore deposits occur near sea-level.

The topography of the north-western portion of Texada island, where the iron-ore deposits occur, is characterized by round-topped, often cliff-bordered hills and ridges, not exceeding 1,000 feet in elevation, and separated by low-lying areas. The slopes of the hills are quite steep and the shore-line bold and rocky, so that some difficulty is found in locating a desirable wharf-site; Gillies bay is the only shelter on the west coast of the island, and as that is located about three miles south from the iron-mines, it has never been considered a convenient or desirable location for a shipping-point.

GEOLOGY.

The geological conditions that surround the occurrences of iron ore on Vancouver and Texada islands are very similar. In both districts the magnetite-deposits occur at or near the contacts between igneous rocks and crystalline limestone. These rocks are referred to by the late Dr. G. M. Dawson as the Vancouver Series of Triassic age, and include not only the entire mass of volcanic materials which unconformably underlie the Cretaceous, but also the interbedded limestones and flaggy argillites and quartzites.

By Chas. H. Clapp the same rocks are referred to as the Vancouver group, which he has mapped and subdivided as follows:—

Jurassic (?)—Metchosin volcanics (basalt, tuff, etc.).	} Vancouver group.
Jurassic or Triassic—Sicker series (andesitic flows, tuff, etc.).	
Lower Jurassic—Sutton formation (crystalline limestone).	
Lower Mesozoic, possibly, in part, Palaeozoic—Vancouver volcanics (andesite, amygdaloid porphyries, tuff, etc.).	
Jurassic or Triassic (?)—Nitinat formation (crystalline limestone).	

R. G. McConnell, in Memoir No. 58, Canadian Department of Mines, Geological Survey, refers to the deposits of magnetite on Texada island as occurring at and near the contact of quartz diorites and crystalline limestone classified as the Marble Bay formation, also at the contact between quartz diorite and porphyrites assigned to the Texada group by O. E. LeRoy, of the Canadian Geological Survey. McConnell considers that the quartz diorite should be tentatively assigned to the Upper Jurassic age, the porphyrites to the Lower Jurassic, and the Marble Bay limestone to either the Triassic or Jurassic periods, but states that the ages assigned are tentative only, as definite fossil evidence is wanting.

ORE-DEPOSITS.

The general characteristics of the bodies of magnetite on the coasts of both Vancouver and Texada islands show marked similarity as regards the genesis of the ore-structure of the bodies and associated minerals. All of the authorities agree that the genesis of the magnetite ore is due to contact replacement of the limestone, and sometimes also of the contact basic igneous rocks, and that the most important deposits belong to the contact-metamorphic type, although in Clapp's report he refers also to deposits occurring as impregnated schists in the Sicker series, as well as replacement or segregation deposits in the Sooke gabbro. The writer's observations show that the contact-metamorphic and replacement or segregation deposits are the only types that at present, at least, have commercial value; in fact, such is also the opinion of Mr. Clapp, as expressed in his report quoted.

The structure of each of the contact-metamorphic deposits examined by the writer is that of a mass or lens usually forming the end or flank of a ridge or occurring as a steep cliff standing out as a prominent landmark, which on account of its hardness has escaped destruction from the forces of erosion and denudation. These masses or lenses often reach dimensions of great extent in superficial area, sometimes several hundred feet in length and more than 100 feet in width, but have irregular outlines.

GENESIS.

Chas. H. Clapp, in the Memoir No. 13, Southern Vancouver Island, of the Geological Survey, 1912, pages 192, 193, gives the following theory of the origin of the contact deposits of magnetite, which is quoted below because the majority of the deposits examined by the writer belong to that type:—

"As the occurrence of the magnetite bodies is restricted to the contacts of the marble and the intrusive plutonic rocks, there can be little question that they owe their origin to the contact action of the plutonic rocks on the marble. This conclusion or theory has been substantiated by observations in many parts of the world. The original limestones, to judge from the residual lenses now remaining, and from the absence of other sedimentary rocks in the Nitinat formation, were comparatively pure carbonates of lime and magnesia. Although the Nitinat marbles have been invaded by the granitic rocks to such an extent that the present masses are virtually large 'roof pendants' in the batholiths, in no case do pure marbles occur

in actual contact with the plutonic rocks. They must, therefore, have been subject to profound alteration. The magnetite bodies are usually developed in the altered or metamorphosed marble, but are occasionally in contact with the basic and schistose diorite, and more rarely with the unaltered marble.

"An exceptionally good contact of the magnetite with pure marble occurs on the *Conqueror* claim, on Bugaboo creek. There the magnetite body, which forms a cliff 30 to 40 feet high over which the creek falls, is in contact with a mass of white crystalline marble, at least 100 yards in width, which occurs down-stream, that is to the north. Irregular magnetite veins extend from the magnetite body into the pure marble, brecciating it and including blocks of marble much as apophyses of an igneous rock would brecciate and include fragments of an invaded formation. From the above evidence it is seen that the magnetite-deposits of the Nitinat formation not only owe their origin to the intrusion of the plutonic rocks, but since it seems as if the original limestones were pure, the minerals of the deposit have apparently been derived from the intruding batholith. After the limestones had been more or less contact-metamorphosed, as inclusions of silicates occur in the magnetite, solutions of magnetite, with small amounts of sulphides, penetrated the contact zone and replaced it in part.

"The solutions were apparently very concentrated, virtually magnetite magma, since they intruded and brecciated the sheared diorite and unaltered marbles in much the same manner as rock magma intrudes and brecciates. Very large deposits of magnetite supposed to have been formed in a similar manner—that is, by the intrusion of concentrated magnetite solutions or magnetite magma—occur in Norway, the famous deposits of Kirunavaara. Similar contact deposits have been recognized by several observers, and in recent classifications of ore-bodies have been made a separate type of contact deposits, the magnetite type."

The associated minerals found with the magnetite are the usual contact-metamorphic minerals, principally epidote, andradite (lime-iron garnet), augite, and varieties of amphibole.

The distribution of the lenses of magnetite are noticeably very erratic, as they are found along the contact of lime diorite, lime porphyrite, porphyrite diorite, and also in some cases are found enclosed in all three formations at considerable distances from their boundaries. In two cases, at least, on Texada Island, as well as in some instances on Vancouver Island, lenses of magnetite have formed at the ends of quartz-diorite dykes.

Up to the present time there has been practically no exploration on any of the deposits of magnetite to determine the question of continuity of the ore to a depth below 430 feet from the apex of the outcrop, and that has only been done at one point on Texada Island; consequently the question as to the conditions in respect to the depth to which the various ore-deposits may maintain persistency is yet to be determined. The conditions surrounding some of the magnetite-deposits on Vancouver Island suggests shallowness, but until prospecting with diamond-drill has been done the question must remain open, so far as actual proof is concerned.

THE MINES, SOOKE DISTRICT.

The deposits of iron ore in this portion of Vancouver Island belong to the type classified by Clapp as "replacement or segregation deposits in the Sooke gabbro."

As no work has been done since 1900 on any of the magnetite-deposits in this district, the writer did not examine them during the past summer, as the conditions are the same as when an examination was made by Herbert Carmichael in 1902 and reported on in the Minister of Mines' Report for that year, as follows: "Magnetic iron has been known for many years to exist at Sooke, on the peninsula to the east of Sooke harbour, where there are very extensive surface exposures. These deposits were mentioned by Dr. Dawson in 1887, who said: 'The deposit is rather of the

nature of a stockwork than a true vein, but can be traced for some distance in a north-easterly and south-westerly direction, and in places shows from 10 to 20 feet of nearly pure ore. The country-rock is a crystalline diorite, containing much hornblende. Assays on specimens of the ore gave from 40 to 72 per cent. metallic iron, the samples being all taken from very near the surface.

"A sample of the country-rock from this locality was recently sent to Dr. Barlow, Petrographer to the Geological Survey of Canada, who reports as follows: 'The hand specimen shows a porphyritic rock made up chiefly of pale yellowish-green phenocrysts of plagioclase, with very little ground-mass. Under the microscope it seems to be an olivine diabase made up chiefly of plagioclase, probably labradorite, olivine, pyroxene, and hornblende. Much of the olivine has been converted into serpentine with the separation of iron ore.'"

Carmichael's report next describes the *Ralph* mineral claim, situated on the headland of East Sooke, near the entrance to the harbour (near Lot 111), which he describes as: "A deposit of magnetite carrying more or less copper values, but not of sufficient grade to pay for extraction unless the mixed ore could be used as a flux in a copper-smelter." The only work mentioned in the report is a shaft and a short tunnel, the former being described as full of water, and the latter as not having been driven sufficiently far to reach the magnetite exposed in the shaft.

Other exposures of magnetite mixed with pyrrhotite, iron pyrites, and chalcopyrite are mentioned as occurring on Lots 79 and 83 near the *Ralph* mineral claim in the same district. Some stripping and open-cut work is mentioned as having been done, but not enough to demonstrate any commercial value.

Apparently the bulk of the magnetite in the Sooke district is so much mixed with chalcopyrite as to be unsuitable for a manufacture of pig-iron because of the contamination of copper, while at the same time it is not sufficiently high in copper to give it commercial value as a copper ore, except possibly as a flux.

PORT SAN JUAN, ORANGE COUNTY, CALIFORNIA.

This district is known by both names, the older, being the older, is still retained on the maps, while the latter name is used locally and by the postal authorities.

The deposits of magnetite in this district occur on the Gordon river and on some of its tributaries, notably on Bugaboo creek. The Gordon river flows into the head of San Juan bay from the north, and is about twenty miles long, heading in the mountains on the west side of Cowichan lake.

HISTORY.

Prospecting for iron ore on the Gordon river and its tributaries was very actively prosecuted during 1898 and for a few years later, during which time a large number of mineral claims were located, on some of which considerable development-work was done, notably on the *Gordon River* group, owned by the Gordon River Iron Ore Company; also the *Bugaboo* group, the property of the same owners; and on the *Conqueror* group, owned by a Victoria syndicate.

This work was being carried on during 1902, when Herbert Carmichael, then Provincial Assayer, made the examinations which are the basis of his report in the Minister of Mines' Report for that year. Later all work was suspended, and in 1907, when Einar Lindeman was making an examination for the Mines Branch, Canadian Department of Mines, no work was being done on any of the properties, nor has any been done since.

Owing to these facts, and because the writer had made an examination for private interests several years ago, it was not considered necessary for him to visit the district during the past summer, especially as none of the owners had representatives on the ground; therefore the following description of the deposits in this district is a compilation from the reports referred to above.

This group of mineral claims contains the following named **Gordon River** eleven claims, viz.: *Rose, Sophia, Rambler, Jen, Paving Hill, Pig Iron, Cold Steel, Max, Max Frac., Fizz, and Fizz Frac.*; and is owned by the Gordon River Iron Ore Company. The total area contained in the group is 352.22 acres. The property is situated on the north bank of the Gordon river about five miles from salt water, and is connected with San Juan bay by a good trail.

The development-work on the group has been principally done on the *Rose* claim, on which a shaft has been sunk to a depth of about 300 feet on an outcrop of magnetite, and drifts driven at the 100-, 200-, and 300-foot levels. Carmichael's description of this shaft is as follows: "Close to the camp a shaft had been sunk about 300 feet on a magnetite outcrop, which appeared to dip into the hill. At about 100 feet down this shaft a cross cut drift had been run to the north. This drift was not examined. It was reported by the foreman to be boarded up, and all work had been suspended for the time at this point, but it was stated by the management that the drift had been run for about 40 feet, and had cut diagonally through about 18 feet of ore mixed with country-rock. Similar drifts had been set off at the 200- and 300-foot levels simultaneously, that at the 200-foot level being now in about 18 feet, and that at the 300-foot not so far. In neither of these drifts nor in the shaft was any ore visible, the rock passed through being chiefly diorite, though, of course, these drifts had not been driven far enough to strike the ore-body, should it continue at the surface dip to this depth."

From the foregoing description, the only occurrence of magnetite exposed underground is on the 100-foot level, where, the management stated, "the drift cut diagonally through 18 feet of ore mixed with country-rock." There is consequently no data on which any tonnage of actual ore, or even possible ore, can be estimated.

Other outcroppings of magnetite occur along the Gordon river on both banks for about a mile, following the contact between the Nitinat marble and plutonic rocks. The work, consisting of trenching at various intervals, shows that the outcroppings are apparently disconnected lenses. Further systematic prospecting is necessary in order to demonstrate the extent of the ore-bodies and determine their commercial value.

There are ten mineral claims in the *Bugaboo Creek* group, named as follows: *War, Ar, Ar Frac., Tar, Gen, Warren, Gen, French, Little Boba, Baden Powell, Gen, White, and Sirdar*. The total area is 381.67 acres. This property is now also held by the Gordon River Iron Ore Company. The most important of the claims are the *Baden Powell, Little Boba, and Sirdar*, which are in the Gordon valley, about seven miles from San Juan harbour.

The following description of these mineral claims is copied from Einar Lindeman's "Iron Ore Deposits of Vancouver and Texada Islands, British Columbia," published by the Canada Department of Mines in the Mines Branch Bull. No. 47, 1910, page 10. "An outcrop of magnetite is found on the flank of a ridge, along which it can be traced for 350 feet. In several places on the ridge a sharp contact between the ore and an igneous rock was observed. About 90 feet below this contact a tunnel 114 feet long had been run directly into the hill, showing magnetite in its full length, with the exception of a diorite dyke 8 feet wide about 30 feet from the mouth.

"An average sample of the ore taken along the tunnel gave the following analysis:—

	Per Cent.
Insoluble matter	8.88
Iron	58.30
Sulphur	2.75
Phosphorus	0.013

"About 35 or 40 feet below this tunnel another tunnel had been run in the same direction for 114 feet into the hill, going through limestone and diorite. The last few feet, however, show magnetite dipping in towards the hill."

From the foregoing description of the underground workings, associated with that of the surface showings, the writer can only roughly estimate tonnage of probable and possible ore, as the data is insufficient to warrant any estimate of actual ore. Of probable ore he estimates 500,000 tons, and allows 250,000 tons, or 50 per cent., additional for possible ore, being a total of 750,000 tons that may be available after further development-work has been done.

"East of this main outcrop, and close to the trail leading down to the main trail up the Gordon valley, several strippings had exposed magnetite, but did not give sufficient information in regard to the extent of the ore-bodies.

"The *Sirdar* mineral claim is situated two miles farther up the valley, and is very similar to the *Baden Powell* and *Little Bobs*. The magnetite outcrops here long the face and brow of a ridge for about 100 feet.

"About 50 feet below the top of the ridge a tunnel has been run 103 feet into the hill, showing the width of the ore to be about 82 feet. An average sample taken along the tunnel gave the following analysis:—

	Per Cent.
Insoluble matter	8.52
Iron	56.57
Sulphur	2.75
Phosphorus	0.121 "

The writer roughly estimates the tonnage of actual ore exposed in the underground workings at 94,000 tons, and allows 47,000 tons, or 50 per cent., additional as possible ore that may be found to be available after further development-work is done.

Since the examinations made by Mr. Lindeman in 1907, on which the above report is based, the writer is reliably informed that practically no further work has been done.

There are fifteen mineral claims in the *Conqueror* group, named as follows: *Cyrus, Daniel, Conqueror, Elijah, Benjamin, Grip of Iron, Iron Master, Iron Master's Son, Iron King, Iron Prince, Jennie Fractional, Joseph, Iron Prince Fractional, Jacob, and David*. The writer examined this property some years ago. Since then it has been examined and reported on by Herbert Carmichael, in the Minister of Mines' Report, 1902; also by Einar Lindeman, in the Canada Department of Mines, Mines Branch Bull. No. 47; and by other engineers for private interests.

The group is on Bugaboo creek, a tributary of the Gordon river, and the main showing of magnetite occurs on the *Conqueror* mineral claim, about eight miles from San Juan bay, at an elevation of about 1,600 feet above sea-level, where the creek crosses a solid body of magnetite about 40 feet high, over which the creek forms a waterfall. This deposit belongs to the contact-metamorphic type, and the ore-body lies between crystalline limestone and diorite.

The maximum width of the ore-body exposed in the bed of the creek is about 100 feet. Surface stripping east of the creek has exposed outcroppings of magnetite for some distance, indicating that the deposit may extend for at least 200 feet in length. About 40 feet below the top of the outcrop a drift has been driven 14 feet long in solid magnetite.

From the foregoing data the writer estimates 10,000 tons of actual ore exposed on three sides, 14 feet long, 100 feet wide, 80 feet deep, but from the exposures he roughly estimates 230,000 tons of probable ore and 120,000 tons of possible ore that further development may make available.

Average samples taken in 1000 by the writer assayed:—

	Per Cent.	Per Cent.
Iron	50.7	62.08
Silica	6.16	4.28
Sulphur	3.06	Trace.
Phosphorus	Nil.	Nil.

A sample taken along the drift by Lindeman assayed:—

	Per Cent.
Iron	67.00
Insoluble matter	4.51
Sulphur	1.00
Phosphorus	0.000

A sample taken by Carmichael assayed:

Iron	60.2
Silica	2.7
Sulphur	0.5

Outcroppings of magnetite occur on some of the other claims in the group, notably on the *Darid*, east of the *Conqueror*. Open-cuts have been made in several places, exposing magnetite of approximately the same grade as the above samples, but the work is not sufficient to warrant an estimate of the tonnage of available ore.

The water-supply in the Gordon river, as well as in Bugaboo creek, is sufficient for ordinary power purposes, as well as for mining and domestic use. The timber is ample for all purposes, including the manufacture of lumber.

Transportation facilities to salt water from any of the mineral claims included in the groups described herein, in the Port Renfrew district, can be installed at reasonable cost. The harbour near the mouth of the Gordon river affords some good sites for bunkers and wharves.

ALBERNI MINING DIVISION.

BARKLEY SOUND DISTRICT.

SARITA RIVER DEPOSITS.

Deposits of magnetite belonging to the contact-metamorphic type, with the ore lying between crystalline limestone and diorite, occur about one mile up the Sarita river and about a quarter of a mile back from the south bank. The Sarita river rises in Sarita lake, flows westward into Numukams bay, in the Eastern channel of Barkley sound, about fifteen miles from Cape Beale, on the west coast of Vancouver Island.

The mail-steamer that leaves Victoria each week during the summer and every ten days during the winter passes within a short distance of the mouth of the river, which has numerous channels that form a wide delta. An alternative route to these deposits is via the Esquimalt and Nanaimo Railway to Port Alberni; thence by launch down the Alberni canal about twenty-five miles to the mouth of the river. A canoe can be rowed to within a short distance of the mining camp, or an old trail can be travelled from the shore of the bay, a short distance south of the delta.

A bluff of iron ore about 50 feet wide, of low grade and very siliceous, occurs on the south bank of the river, about one mile and a half from the mouth. This apparently is the east end of the main ridge in which magnetite-deposits occur farther west, and from the work done was the scene of the earliest attempt to develop the mineral. Several adits were driven into this bluff from the same level, one being 172 feet long, with two drifts driven in opposite directions from the adit, a total length of 107 feet. A winze of unknown depth, as it was full of water, was sunk from the adit at a point 50 feet from the portal. Mineral is exposed for about 70 feet from

the portal; the remainder of the work is in country-rock. The mineralization is a mixture of iron pyrites, magnetite, pyrrhotite, and marcasite.

Average samples assayed:—

	Per Cent.	Per Cent.
Iron	23.8	13.4
Sulphur	14.4	0.0
Phosphorus	Trace.	Trace.
Silica	48.0	68.3

Evidently work was abandoned after the grade of the ore was ascertained, and further prospecting was done along the ridge to the west, because about a quarter of a mile in that direction there is an occurrence of magnetite on the east bank of a swampy creek that crosses the same ridge, as already mentioned. An open-cut 10 feet deep by 120 feet long has been made across a part of the ridge, exposing diorite on the south side, next magnetite 62 feet wide, then crystalline limestone 12 feet wide, then magnetite 45 feet wide, to limestone wall. In this deposit the magnetite is good grade, and the impurities found associated with the ore in the bluff overlooking the river are lacking. The gangue material is garnette.

The writer attempted to trace the deposit on the surface farther to the west, but found it impossible to do so because of fallen timber and heavy growth of bushes, or to connect it with the open-cuts seen by the writer when he made a previous examination, and described in Carmichael's report; consequently a detour was made along the north base of the ridge for about a quarter of a mile to the bluff at the base of which is the portal of the adit described and sketched in that report. To-day this might easily be passed by without notice, so dense is the growth of alder and other bushes, that even the dump containing several hundred tons of ore is hidden, and the face of the bluff of magnetite about 60 feet high, that formed such a prominent landmark after it was stripped years ago, is also hidden.

The adit is 290 feet long, including all of the crooks; it is driven in solid magnetite, along a limestone wall for 111 feet, when diorite is exposed; the adit was continued 18 feet in diorite, but where the magnetite disappeared a turn is made to the left and the adit continued through magnetite 76 feet, with diorite on the south-east side. About 40 feet from the turn diorite shows in the roof, with magnetite underlying it. Gradually the magnetite wedges out, and at 76 feet from the turn practically disappears, except in the floor. At this point the course of the adit is again changed, to the south-east, and driven 60 feet through diorite to the face.

A winze full of water, said to be 7 feet deep, and sunk in magnetite is located 28 feet from the portal of the adit. The body of magnetite in the bluff is 92 feet wide by 60 feet high above the adit level. Climbing the bluff, the elevation of the ridge increases to the east to about 150 feet above sea-level. Test-pits and trenches that were examined show magnetite in several places for about 1,000 feet eastward. The most important of these occurrences is the one on the bank of the swampy creek, already described. This is apparently the farthest east that a good grade of magnetite extends. There is a possibility that the deposits to the east from the long adit are connected and form a continuous ore-body.

A sample from the dump at the portal of the adit assayed:

	Per Cent.
Iron	63.8
Sulphur	0.55
Phosphorus	Trace.
Silica	4.2

A sample reported by Carmichael from the same dump assayed:—

Iron	63.7
Sulphur	0.3
Phosphorus	Trace.
Silica	3.85

A sample reported by Lindeman from the same dump assayed:—

	Per Cent.
Iron	60.80
Sulphur	0.70
Phosphorus	0.004
Insoluble matter	3.81

The quantity of available magnetite in the Sarita River deposits, so far as exposed by the workings, is estimated by the Provincial Mineralogist, in the bulletin published in 1903, at 55,000 tons of "probable or possible ore." Since that time no further work has been done. In this estimate no allowance has been made for possible continuity to a depth below the adit level, which the writer considers is possible, but must remain an open question until proven. Prospecting with a diamond-drill would determine the conditions at depth, and this undoubtedly should be done before any equipment is installed to mine on an extensive scale.

Water-power can be developed on the Sarita river by using the lake at the head for a reservoir. Timber for building, mining, and fuel is very plentiful and easy of access.

COPPER ISLAND DEPOSITS.

This island, also called Taurtoos, is the largest of a chain of islands in Barkley sound, between the Eastern and Middle channels. It rises quite abruptly from the sea on the east side, and reaches an elevation of about 1,000 feet within about half a mile from the shore.

The *Mountain, Barkley, Clifton, Charmer, Pilot Fraction, Rainbow, and Sundram* mineral claims form the group on Copper Island on which magnetite occurs, near the summit, about two miles from the north end. The workings consist of an adit and several open-cuts over a large area which expose extensive bodies of magnetite; sometimes apparently resting on an igneous rock of greenish colour, and in places filling fissures in the country-rock.

The exposures are too irregular and the distribution too erratic to base any calculations as to tonnage of available ore, but there is no doubt but that a very considerable quantity can be obtained from the exposures already made.

Although a belt of limestone occurs a short distance north of the magnetite-deposits, there is none in the immediate vicinity, so that these occurrences of magnetite appear to belong to the type described by Clapp as "replacement or segregation deposits," or such as are described in "Kemp's Ore Deposits," page 63: "The concentration of the magnetite seems to the writer best explained by its settling in the still molten mass until it formed considerable aggregates. When once these rich aggregates have formed they may, in the process of eruption or intrusion, take almost any place in the resulting rock."

The most important development-work has been done on the *Mountain* claim, where there is an adit 64 feet long, with open-cut approach 41 feet long, also an open-cut 100 feet long by about 50 feet deep at the face, and a shallow shaft sunk from the open-cut 50 feet from the entrance. There is also an open-cut between the two mentioned, which is 24 feet long in solid magnetite, but towards the face igneous rock underlies the magnetite, which appears as a blanket, covering the rock up the bluff nearly to the summit.

The open-cut approach to the adit exposes a body of magnetite about 20 feet wide, but in the adit the only magnetite exposed is a body about 6 feet wide in a drift on the right-hand side, at the junction, and about 27 feet from the portal of the adit. These bodies are not connected, and beyond the last mentioned the adit is continued for about 75 feet in country-rock, evidently in the expectation of intersecting the body of magnetite exposed in the open-cut about 60 feet northward, but whether this has been continued sufficiently far requires a survey to determine.

The open-cut northward from the adit is on the same level, and made into a bluff about 50 feet high, above the floor of the open-cut; on the right of the cut about 50 feet from the entrance there is a shaft said to be 12 feet deep, but full of

water. This is sunk in solid magnetite, but whether the bottom shows ore or country-rock the writer could not ascertain, having no means of unwatering the shaft.

There are about 2,000 tons of magnetite of commercial grade on the dumps.

A solid body of magnetite is exposed by the open-cut for about 25 feet, and about 10 feet high; then a narrow granite dyke is cut through, beyond which the cut exposes magnetite mixed with igneous rock for about 45 feet, then igneous rock to the face. On the summit of the bluff there are lenses of magnetite, mixed with considerable garnetite and epidote, covering a width of 52 feet and a length of 330 feet.

Quite extensive outcroppings of magnetite occur towards the west side of Copper island, from the summit of the bluff, in which the long open-cut is made and about 200 feet higher elevation. These are distributed over an area of about 1,000 feet in length and 100 feet in width. The magnetite is more or less mixed with garnetite, epidote, and country-rock in these outcroppings, which occur in low bluffs and knolls.

Masses of float indicate that magnetite occurs in at least one other zone to the south-east from the workings described, as such are seen along a trail to the beach some distance south of the one usually travelled, but no work has been done to prospect that portion of the group of mineral claims. Concentration is necessary in order to produce a marketable grade of magnetite from most of the outcroppings.

It is absolutely impossible for any engineer to make an estimate of tonnage in these deposits; there may be 20,000 tons or even 100,000 of possible ore.

A sample of solid magnetite taken by the writer from the mine workings assayed:—

	Per Cent.
Iron	50.2
Sulphur	1.3
Phosphorus	Nil.
Silica	17.0
A sample reported by Carmichael from the same workings assayed:—	
Iron	50.4
Sulphur	0.3
Phosphorus	0.053
Silica	18.6
A sample reported by Lindeman from the same workings assayed:—	
Iron	52.00
Sulphur	0.230
Phosphorus	0.025
Insoluble matter	16.52

Timber is scarce in the vicinity of the deposits of magnetite at the higher elevations, but plentiful lower down the mountain. Water is not plentiful on the mountain, but there is ample for domestic use near the beach.

Transportation facilities can be installed at a minimum cost from the mine-workings to a bay at Clifton point, distant about half a mile in an air-line.

HENDERSON LAKE DEPOSITS.

Near the head of Henderson lake, which empties into Uchucklesit harbour, at the entrance to Alberni canal, and about ten miles from the harbour, a magnetite-deposit occurs on a small creek on the west side of the lake.

This mineral claim was originally the *Iron Mountain*, and was **Magnetite**. first staked about 1901, but allowed to lapse. Since then it has been staked and abandoned several times until the summer of 1916, when it was restaked by Anthony Watson, of Port Alberni, who has since done considerable open-cut work.

About 250 feet from the lake-shore, and about 100 feet higher elevation, on the south side of a small creek, a continuous deposit of magnetite is exposed by open-cuts for a distance of 130 feet along the precipitous bank of the creep. Apparently this

exposure is across the ore-body which strikes north-west or nearly parallel with the lake-shore, and dips 63 degrees to the north-east. The outcroppings of magnetite can be traced about 30 feet down the creek-bank nearly to water-level, but no continuation of outcroppings are seen across the creek on the north side.

Only a very rough estimate of tonnage of available ore can be made. The writer estimates the *actual* ore at 20,000 tons and the *possible* ore at 280,000 tons.

The mountain rises very abruptly on the south side of the creek, and outcroppings of magnetite occur about 250 feet higher elevation than the open-cuts, but no work has been done. An average sample assayed: Iron, 50 per cent.; sulphur, 0.24 per cent.; phosphorus, nil; silica, 22 per cent.

Timber adapted for all purposes is very plentiful on the claim. The water in the small creek is sufficient for all purposes, including limited power, provided a storage-reservoir is constructed to conserve the supply.

Transportation facilities can be easily installed to the lake, where ore can be loaded on to scows and transported to deep water on Uchucklesit harbour, provided some more dredging is done in the stream that connects the two bodies of water.

UCHUCKLESIT HARBOUR DEPOSITS.

Cascade creek flows into Uchucklesit harbour about one mile and a half from the entrance, and is capable of being developed into one of the greatest water-powers on Vancouver Island; it falls about 2,100 feet in about one mile and a quarter through precipitous canyons.

Water for power purposes is already taken from Cascade creek by the Wallace Fisheries Company, and is used to run the machinery in the cold storage and cannery on Uchucklesit harbour at the foot of Cascade mountain, but in addition to this there is an ample supply for domestic and mining purposes near the head of the creek.

On the *Black Prince No. 2* claim, at the head of this creek, deposits of magnetite and pyrrhotite occur that form bluffs below the summit, and are distributed over the surface on the summit of Cascade mountain, a superficial area between 2 and 3 acres in extent.

These deposits are apparently not of the contact-metamorphic type, although, lower down the mountain, immense masses of crystalline limestone occur in contact with the same greenish-coloured igneous rock as enclose the magnetite-deposits on the summit. The exposures are all lenses, apparently disconnected. The line of strike is north-westerly, the dip about 75 degrees to the east. The development-work consists of large open-cuts; the most important of these is across the face of a bluff of pyrrhotite 25 feet long by 20 feet deep at the face and about 15 feet wide.

The occurrence of the bluff of mineral in such close proximity to magnetite-deposits is noticeable, and a sample was taken merely to determine the contents, and not because it was considered to represent iron ore. The sample is an average from the open-cut, and assayed:—

	Per Cent.
Iron	8.8
Sulphur	5.0
Phosphorus	0.3
Silica	75.5

Another open-cut 24 feet wide by 40 feet long by 7 feet deep is made on a disconnected lens of magnetite about 40 feet higher up the mountain, close to the summit. An average sample from this open-cut assayed:—

	Per Cent.
Iron	70.2
Sulphur	Trace.
Phosphorus	Trace.
Silica	1.4

On the summit of Cascade mountain there are several open-cuts farther to the north-west that expose lenses of magnetite distributed over an area between 2 or 3 acres. The ore exposed in these is apparently about the same grade as the last-mentioned sample.

A rough estimate of the tonnage of magnetite that is classed as *actual* ore exposed on this property is made by the writer at 15,000 tons, with an additional 15,000 tons of *possible* ore that may be made available by further development-work.

Timber for mining and fuel is plentiful in the vicinity of the outcroppings of magnetite. The opportunity for installing transportation facilities is exceptionally good, as an aerial tramway about 6,500 feet long would connect the mine with a wharf at deep water, where ocean-going vessels could load.

This property is on Cascade creek at 900 feet elevation, where **Sunshine Group.** deposits of magnetite occur of the contact-metamorphic type, lying between crystalline limestone and igneous rock, but those examined appear to carry too much copper to be of value for iron-making. The claims have been prospected to some extent to determine their value as producers of copper ore, and during 1916 a small shipment of ore was made to a copper-smelter by the Woodworth Bros., who held a bond on the group, but the returns were not made public, and as work was not continued it appeared as though conditions were not satisfactory.

The writer examined two adits on the *Fern* mineral claim, one of the *Sunshine* group. These adits are driven into the steep creek-bank near Cascade falls; each is about 60 feet long, driven across lenses of magnetite, one about 12 feet wide; the other could not be closely examined because of its caved condition, but the dump contains magnetite with the small content in copper.

The workings from which the small shipment of copper-bearing ore was made were not examined. They are some distance from the creek, and the time at the writer's disposal was not sufficient to permit an examination.

ALBERNI CANAL.

This group contains the *Defiance* and the *Defiance No. 1* **Defiance Group.** Crown-granted mineral claims, situated at the headwaters of a tributary of Handy creek, which flows into the Alberni canal on the west side about seventeen miles below Port Alberni, and is owned by Michael Commoford, of Alberni. The distance from the shore to the claims is about two miles by trail, but only about 4,000 feet in an air-line. The elevation is about 1,000 feet above sea-level.

Magnetite-deposits with lenticular structure occur on a comparatively flat bench; two of these occurrences are cut by a small creek, while the third covers a flat about 50 feet square. The deposits belong to the contact-metamorphic type, the ore lying between crystalline limestone and an igneous rock of the Vancouver series.

The last-mentioned occurrence has been exposed by stripping, but no attempt has been made to determine the conditions at depth by sinking in the ore, but an adit has been driven from a bench about 20 feet lower elevation, evidently with the expectation of intersecting the magnetite on that level, which the dump would indicate had been done at or near the face, as there is a small quantity of magnetite mixed with chalcopyrite on the dump that apparently was the last material taken from the adit. A sample of this ore assayed:

Gold	Trace.
Silver	1.2 oz.
Copper	3.3 per cent.
Iron	52.6 ..
Sulphur	1.2 ..
Phosphorus	Nil.
Silica	12.1 per cent.

The adit could not be examined because of its caved condition near the portal and the depth of water, caused by a dam of debris.

One of the other occurrences of magnetite is exposed in an open-cut approach about 15 feet long and an adit driven in magnetite 20 feet long, with igneous rock as one wall. A crosscut about 8 feet long at the face of the adit is driven to limestone. This work shows a width of about 12 feet of solid magnetite. The deposit is about 60 feet long, striking north-west and dipping vertically. At the face of the adit there are about 35 feet of backs above the level of the floor, but no attempt has been made to determine the occurrence of magnetite below that level. The magnetite shows very little impurities; the only gangue material is garnetite in small quantities.

An average sample from a large dump at the portal of the adit assayed:—

	Per Cent.
Iron	61.0
Sulphur	Trace.
Phosphorus	Nil.
Silica	3.3

Another occurrence of magnetite mixed with small particles of chalcopyrite outcrops in the contact between crystalline limestone and igneous rock, about 150 feet to the north-west from that last described. The ore-body is about 4 feet wide and has been prospected by an open-cut.

No attempt is made by the writer to estimate tonnage of ore occurring on this property, as it is impossible to make even a shrewd guess.

An average sample from across the outcropping assayed:—

	Per Cent.
Gold	Trace.
Silver	Trace.
Copper	0.2
Iron	65.8
Sulphur	2.2
Phosphorus	Trace.
Silica	4.8

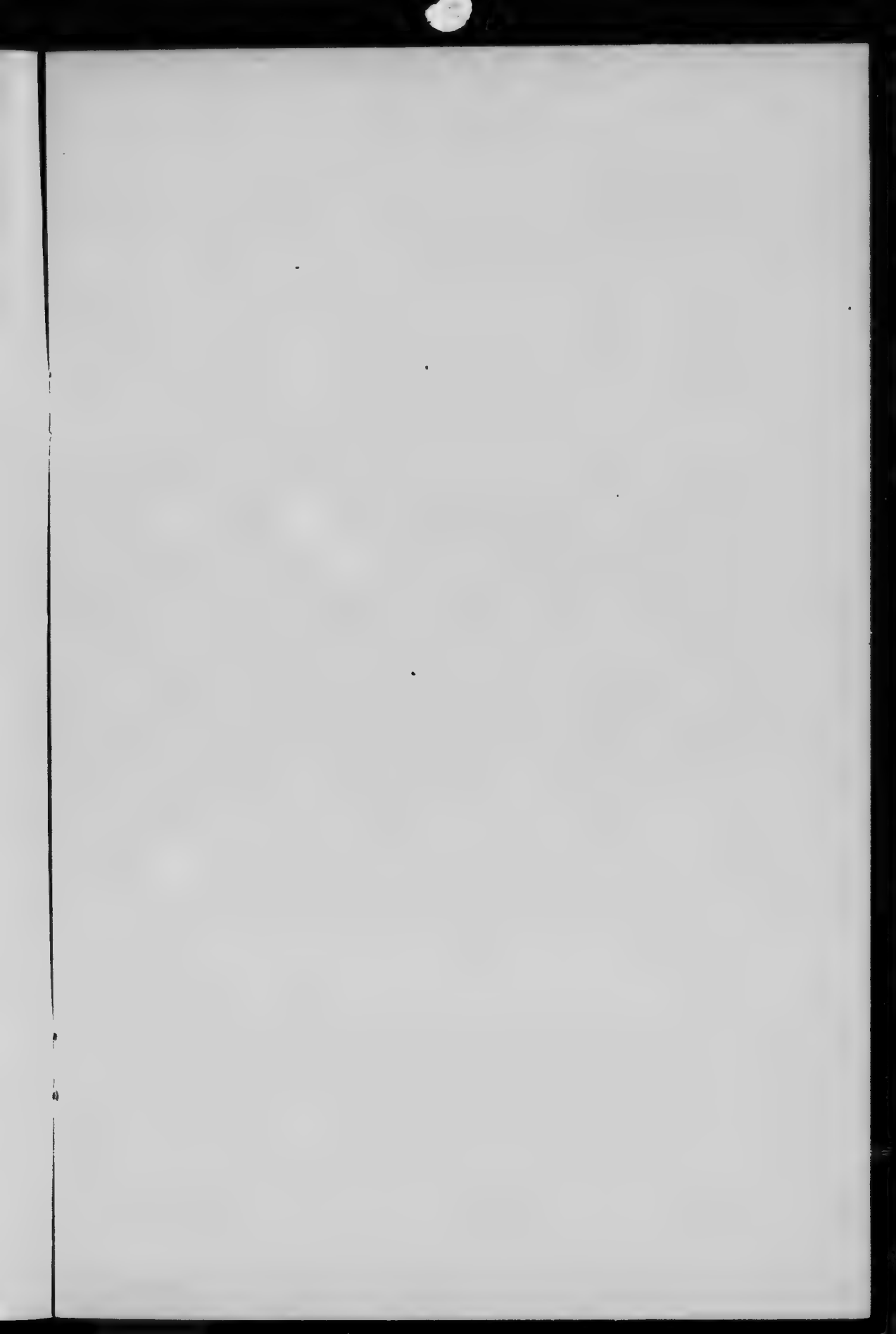
Water and timber are plentiful for mining and domestic purposes.

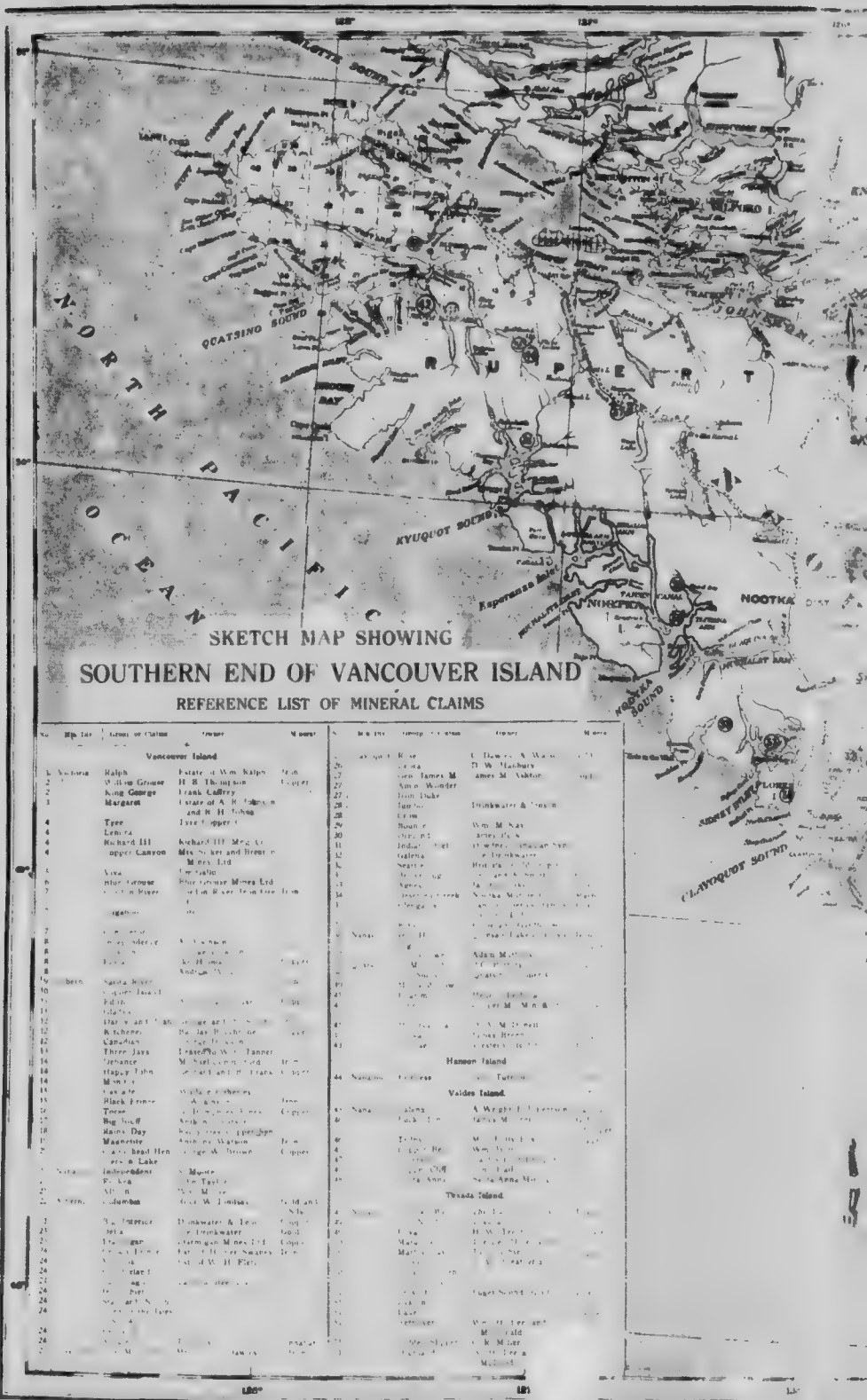
Transportation for ore and supplies on any large scale would necessitate the construction of an aerial tramway across the *Monitor* group of mineral claims to the shore of Alberni canal, near the mouth of Handy creek.

These mineral claims are at Smith's Landing and on the east **Darby and Joan** shore of Alberni canal, twelve miles below Port Alberni. Occurrences of magnetite outcrop along the ridge and base of a low hill, about half a mile from the canal, that can be traced for about 120 feet to the north from the point where the outcroppings are first seen, but whether unbroken continuity is maintained has not been determined. This deposit of magnetite appears to fill a fissure in diorite, which is from dark to light green in colour, and although there is a wide belt of crystalline limestone about half a mile south of the magnetite, there is no contact between the diorite and limestone showing near it.

The only development-work done is a series of open-cuts and two short adits. One of these open-cuts at the south end of the ore-body is 23 feet long, and crosscuts magnetite mixed with iron pyrites and pyrrhotite for 20 feet. The next open-cut is about 100 feet farther north; in this the ore-body is narrower, but the magnetite is much purer.

Another open-cut is 36 feet farther north; this is an approach 24 feet long to an adit 9 feet long driven through diorite, except through about 1 foot of magnetite at the portal. Another open-cut approach to an adit is 80 feet farther north, but because of caving this could not be examined. Stripping on the hill about 65 feet above the level of the work showed magnetite, but the dump at the entrance to the open-cut and adit was all country-rock.







Lindeman used a dip needle in his examinations, and in his report states: "No magnetic attraction could be noticed north of the ore-outcrop, but the attraction was strong south of it for a distance of about 70 feet."

An average sample of the ore-dump gave the following analysis:—

	Per Cent.
Insoluble matter	25.95
Iron	50.96
Phosphorus	0.004
Sulphur	0.083

Carmichael's report states: "A rough but approximate average sample of the ore on the dump gave the following analysis:—

	Per Cent.
Iron	55.9
Silica	16.0
Sulphur	1.0
Copper	None."

The opportunity for cheap transportation is particularly good; a surface tramway about half a mile long, with no excessive grades to overcome, would connect the deposits with a sheltered harbour on the canal, where ocean vessels could safely lie.

Timber and water are plentiful on the property, but whether the water-supply has a sufficient fall for power needs investigation.

KENNEDY LAKE DISTRICT.

These mineral claims are owned by Mrs. W. T. Dawley, of **Iron Mountain** (Clayoquot, and were originally staked because of the discovery and **Chieftain**, of a vein of gold-bearing quartz. Magnetite-deposits of the contact-metamorphic type occur about three miles northward from the head of Kennedy lake, and twelve miles north-westward, in an air-line, from the deposit near the head of Henderson lake. This section is very mountainous, cut by deep precipitous gorges which are the beds of creeks. One of these creeks heads at an elevation of about 2,700 feet above sea-level and flows through deep canyons. The lowest occurrence of magnetite seen by the writer is an outcropping in the steep bank of the creek, at an elevation of about 1,800 feet, on the *Chieftain* claim. The exposure of magnetite is about 20 feet long, but whether this is along the strike or across the body cannot be determined until some work is done.

An average sample of the outcrop assayed:—

	Per Cent.
Iron	30.10
Sulphur	0.31
Phosphorus	Trace.
Silica	51.5

This outcropping occurs under a limestone bluff, and overlies an igneous rock. Some development-work is said to have been done farther up the creek on the opposite side, but the guide with the writer was unable to locate it because of the great growth of bushes and lack of a trail.

Outcroppings of magnetite occur at several points on the sides of steep ravines farther up the same creek, but no work has been done, and as the slopes are almost perpendicular, too steep to climb, no examination could be made.

The mineral claims were staked originally because of the occurrence of gold-bearing quartz at an elevation of 2,400 feet above sea-level, which has been prospected by an adit.

The *Iron Mountain* mineral claim adjoins the *Chieftain* on the north and occupies a part of the summit of the mountain about 1,000 feet higher elevation, where outcroppings of magnetite occur that need development-work before any estimate can be made as to extent.

Lindeman reports an analysis of a sample of magnetite from this group as follows:—

	Per Cent.
Insoluble matter	7.64
Iron	63.07
Phosphorus	0.016
Sulphur	0.043

HESQUIAT LAKE DISTRICT.

Owing to the absence of all the owners, the writer, accompanied by two Indian guides, spent a day trying to locate the deposits of magnetite, described by Carmichael in the Minister of Mines' Report for 1902 as occurring in the vicinity of Hesquiat lake, but was unable to find any trace of trails or blazes leading to outcroppings, nor could any one be found who had any knowledge of any work having been done in recent years; consequently the description from that report is copied, as follows:—

"*Agnes No. 1 and No. 2.*—These claims are situated on the east shore of Hesquiat lake, at an elevation of 175 feet above and some 4,000 feet back from the water, and are reached at present by a blazed trail only. The properties are owned by Messrs. Jacobsen, Ike, and Roseberry, of Clayoquot, and were located in June, 1902. A small creek runs through the locations, and in the banks of this stream there have been exposed some outcrops of magnetic iron, a few yards in extent only, which form the basis of these locations. Assays of average samples gave about 50 per cent. iron, 13.1 per cent. silica, no copper. These outcrops are apparently on the contact (limestone with an eruptive rock, probably diabase) mentioned and extend for some distance. Other than these exposures made by the creek, there is only a little surface stripping, the surface elsewhere being covered with soil. The work done simply proves the existence here of magnetite, and it is quite possible and even probable that further development will prove up a more extensive body of ore.

"*Violet Mineral Claim.*—This claim, owned by F. Jacobsen, of Clayoquot, is situated on the west side of the lake, opposite the *Agnes*, probably on an extension of the same contact already mentioned. The principal outcrop is at an elevation of about 300 feet above the lake and less than a quarter of a mile back from the water, and is reached by a steep trail from the shore. Here there is an exposure of magnetite some 15 feet wide, developed by an open-cut into the hillside, 12 feet long and about 4 to 5 feet deep at the face, showing up very clean and solid ore, a sample of which taken for assay gave 59.8 per cent. iron, 11 per cent. silica, 0.55 per cent. sulphur, and no copper. Some 400 feet higher up the hill there is another small exposure of similar ore. Where the rocks were exposed the ore appeared to lie on the lime-diabase contact, which is more clearly defined on this the west side of the lake."

SECHART.

Sechart peninsula is bounded on the east by Effingham inlet, an arm of Barkley sound; on the south by Sechart channel, that connects the Middle and Western channels of Barkley sound; on the west by the Western channel of Barkley sound; and on the north by Pipestem inlet, except a narrow neck of mountain range between the heads of the two inlets.

The Broughton mountain range forms the peninsula; it rises to an elevation of about 3,000 feet by a series of benches and gradual grades from the shore, and magnetite-deposits occur on its southern slope above an elevation about 700 feet.

During the early nineties Captain Anderson located several mineral claims because of the occurrences of magnetite, some of which he sold during 1901 to the Pacific Steel Company, of the State of Washington, and others to the Tacoma Steel

Company, of the same State. The claims were later Crown-granted as lots numbered 456, 457, 458, 459, 374, 302, 005, and 000, and at present are assessed to the following owners:—

Lot No. 456, *Crown Prince* claim, to the estate of the late Homer Swaney.

Lot No. 457, *Victoria* claim, to the estate of the late W. H. Flett.

Lot No. 458, *Old Ireland* claim, to the estate of the late W. H. Flett.

Lot No. 459, *Bald Eagle* claim, to the Tacoma Steel Company.

Lot No. 374, *Iron Chief* claim, to the Tacoma Steel Company.

Lot No. 302, *Standard No. 6* claim, to the Tacoma Steel Company.

Lot No. 005, *Lord of the Isles No. 4* claim, to the Tacoma Steel Company.

Lot No. 000, *Emily R.* claim, to the Tacoma Steel Company.

The most important deposits of magnetite occur on the *Crown Prince*, *Lord of the Isles*, and *Bald Eagle* mineral claims, where the most development-work has been done. These occurrences belong to the contact-metamorphic type, in which the ore lies between crystalline limestone and hornblende igneous rock coloured in varying tints of green.

This mineral claim is on the east slope of the Broughton range of mountains, overlooking Edingham Inlet, at an elevation of about 1,000 feet and about two miles and a half by trail from the beach of Sechart channel at Anderson's camp, but from deep water in canoe pass the distance is considerably less. The most extensive outcroppings of magnetite occur in a prominent ridge where wide bands of magnetite are exposed alternating with bodies of green igneous rock, much sheared, altered, and quite schistose near the magnetite. The strike of the bands of magnetite is south-eastward, the dip being 45 degrees southward.

The face of the ridge is stripped about 200 feet long by 70 feet high up the slope about 45 degrees, exposing magnetite mixed with country-rock in the banded structure for 70 feet along the ridge, then country-rock for 100 feet, then magnetite for 33 feet.

Near the base of the ridge an open-cut approach to an adit has been made through one outcrop of magnetite for about 33 feet, but the portal of the adit is in the green altered igneous rock; this was driven through about 50 feet, where a narrow seam of calcite occurs followed by a body about 10 feet wide of arsenical pyrite mixed with iron pyrite and magnetite, which changes to a mixture of magnetite and green country-rock, then to solid magnetite, through which the adit is driven nearly 20 feet to the face, and was still in ore.

An average sample across the face assayed:—

	Per Cent.
Iron	56.6
Sulphur	0.72
Phosphorus	Nil.
Silica	19.0

A branch from the adit starting about 50 feet from the portal, was driven to the left for 72 feet; this exposes magnetite for 28 feet adjoining the calcite 5 feet from the junction, then continues through dark-green hornblende country-rock to the face. The last 34 feet of the branch adit is apparently under the magnetite exposed in the main adit, as the dip of that body is 45 degrees to the southward, or to the right of the opening.

From the condition of the workings, as seen by the writer, only a very rough guess can be made as to the tonnage of ore available. Of *actual* ore the tonnage may be estimated at 75,000 tons, while the tonnage of *possible* ore may be placed at an additional 200,000 tons.

Average samples taken along 28 feet on the left side of the branch adit assayed:—

	Per Cent.	Per Cent.
Iron	54.4	55.6
Sulphur	14	0.4
Phosphorus	Nil.	Trace.
Silica	21.2	17.6

Carmichael reports an assay from the same workings as:—

	Per Cent.
" Iron	48.4
Sulphur	0.7
Phosphorus	Trace.
Titanium	Trace.
Copper	Nil."

Lindeman reports an assay from the same workings as:—

	Per Cent.
" Iron	48.06
Sulphur	0.623
Phosphorus	0.006
Insoluble matter	23.22 "

This mineral claim is about 2,000 feet west from the *Crown Lord of the Isles*. *Prince*. It adjoins the *Victoria*, which lies between the two first-named claims, and is reached by a trail about two miles and a half long from the beach at Anderson's camp. A deposit of magnetite outcrops on the face of a precipitous bluff at about 850 feet elevation.

The face of the bluff is heavily stained with iron from the decomposition of iron pyrites, and the magnetite is mixed with pyrites, garnette, and limestone. An adit is driven towards the north in magnetite, along a wall of green hornblende igneous rock, for about 20 feet, then a belt of crystalline limestone is exposed and the course of the adit changed eastward. This course is continued for about 37 feet, driven in magnetite along a limestone wall on the north. At the face there is a winze, apparently sunk in magnetite; this winze is of unknown depth, and being full of water could not be examined.

The dimensions are 13 x 10 feet across the top, with the east wall in igneous country-rock that appears to cut off the ore. The adit is continued 40 feet northward in limestone beyond the turn to the east. It is impossible to estimate quantity of magnetite from the work done, which shows that the occurrence is very irregular in outline, lenticular in structure, and apparently not very extensive, unless drilling should prove that it maintains continuity with depth. The dip of the limestone wall in the east drift is nearly vertical, and it is possible that the magnetite may continue down along this wall.

A grab sample from the dump assayed:—

	Per Cent.
Iron	50.4
Sulphur	2.5
Phosphorus	Trace.
Insoluble matter	10.6

This claim is west and adjoining the *Lord of the Isles*; it is reached by an old trail that branches off from that leading to the last-mentioned claim, and is about three miles from the beach at Anderson's camp. Outcroppings of magnetite occur on the face of a steep bluff at about 1,000 feet elevation above sea-level. This outcrop measures about 75 feet long, by about 50 feet up the slope of the bluff at the widest point. The occurrence of magnetite has the appearance of a blanket covering the light-coloured igneous rock that forms the bluff. An adit is driven 72 feet into the bluff under the outcropping, about 40 feet vertical measurement below the top, and at the face a drift

is driven 45 feet to the right. No magnetite is exposed by this work, which confirms the blanket-structure theory, but farther up the mountain there is a contact between crystalline limestone and igneous rock, similar to that underlying the magnetite on the face of the bluff, and at the contact an outcropping of magnetite occurs, but apparently not of sufficient extent to be of importance.

A sample from the bluff assayed:—

	Per Cent.
Iron	66.7
Sulphur	Trace.
Phosphorus	Trace.
Silica	13.6

HEAD BAY, NOOTKA SOUND DISTRICT.

These mineral claims are situated about one mile from the head of Head bay, at the upper end of Tlupana arm, Nootka Sound. **Glengarry and Stormont.** The original locators sold a two-thirds interest in the property a few years ago to the Wellington Colliery Company, through the late William Sutton, which interest passed to the successors of that company, the Canadian Collieries (Dunsmuir), Limited, the remaining one-third being owned by Clarence Dawley, of Clayoquot.

The claims are staked from south to north, with the No. 1 stakes adjoining, and within the boundaries there is a ridge that reaches an elevation of about 800 feet and extends across both claims from south-eastward. Magnetite-deposits occur along the ridge, of the contact-metamorphic type, lying between crystalline limestone and diorite. Garnetite is the only gangue material associated with the magnetite in any appreciable quantity.

Open-cuts and stripping along the north slope of the ridge have exposed solid masses of magnetite which can be traced in a nearly continuous line for several hundred feet, and varying in width from about 7 to 55 feet. Some of the open-cuts are about 20 feet high at the face, and stripping, in some places, exposes magnetite outcroppings extending downwards from the summit to near the base of the ridge for a continuous length on the incline of about 200 feet, and a maximum width of 40 to 55 feet.

A general sample representing about an average of the deposits assayed:—

	Per Cent.
Iron	56.8
Sulphur	0.1
Phosphorus	Trace.
Silica	1.6

Lindeman reports a sample from this property that assayed:—

" Iron	66.17
Sulphur	0.017
Phosphorus	0.016
Silica	6.10 "

Apparently the quantity of magnetite on these claims is exceptionally large. Considering the exposures seen by the writer, and estimating from approximate measurements, he figures that he is safe in placing the tonnage of *actual* ore available for quarrying at 250,000 tons, with an additional 250,000 tons of *probable* ore and 750,000 tons of *possible* ore that may be exposed by further development-work. The deposits are very favourably situated to ensure mining and transportation at a minimum cost.

Apparently the magnetite can be quarried from the north slope of the ridge to a very considerable depth, for a length of several hundred feet and an average width of about 40 or 50 feet, as seen by the writer. This would ensure cheap mining for

a very large tonnage. A surface tramway can be constructed to the base of the ridge from deep water in a sheltered harbour with a reasonable grade, where if necessary a connection can be made with a short gravity or an aerial tramway.

There is a plentiful supply of water except for power purposes. Timber is quite plentiful for all purposes, including saw-logs for lumber.

To the southward from the *Otengarry* and *Stormont* claims *Fido*, a mountain-slope rises to an elevation of about 1,500 feet above sea-level, almost within the length of one mineral claim. The *Fido* mineral claim is located on the north slope of this mountain and adjoins the south line of the *Otengarry* and *Stormont*, the No. 1 post of the *Fido* being on the south line of those claims, 200 feet west from their No. 2 posts.

Wm. Poole and J. H. Gardhouse, of Nootka, own the *Fido* claim, and have prospected it to some extent by stripping and open-cuts, which have exposed large bodies of magnetite on the north slope of the mountain southward from those exposed on the *Otengarry* and *Stormont* claims. The grade of this magnetite is so near that in the samples taken from those claims there was no necessity for sampling.

It is to be regretted that no diamond-drill boring or other development-work has been done on any of these deposits of magnetite, because the surface indications promise so favourably with regard to extent.

The writer can only estimate roughly a tonnage of *probable* and *possible* ore, as there is no work done by which actual ore can be measured. This estimate is placed at 50,000 tons of *probable* ore and 200,000 tons of *possible* ore.

WEST ARM, QUATSINO SOUND.

Some years ago a large number of claims were located in the vicinity of Coal harbour, near the east end of the West arm of Quatsino sound, for bog-iron ore, a form of limonite, some of which were sold to the Moore Investment Company, of Seattle, which operated the blast-furnace at Irondale, in the State of Washington, for a few months, and some shipments of this bog-ore were made, but since that enterprise failed the mineral claims have reverted to the Metropolitan Trust Company, of New York, which acquired the assets of the original purchasers.

The most important of the deposits occur about one mile west from Coal Harbour, in and on the border of swampy basins, and on the ranges of adjoining hills.

The origin of bog-ore is described in Kemp's "Ore Deposits of the United States and Canada," page 87, as follows: "Bog-ore, beds of limonite, superficially formed in marshes, swamps, and pools of standing water. The general circulation of water through the rocks enables it very frequently to take up iron in solution. Ferruginous minerals are amongst the first and easiest that fall a prey to alteration. Carbonic acid in the water aids in dissolving the iron, which thus, in waters containing an excess of CO_2 , passes into solution as the protocarbonate (FeCO_3). Organic acids may also play a part. The alteration of pyrite affords sulphuric acid and ferrous sulphate, and the latter enters readily into solution. On meeting calcium carbonate, both ferric and ferrous sulphate are decomposed, yielding in the first place calcium sulphate, ferric hydrate, and carbonic acid; in the second place, if air is absent, ferrous carbonate and calcium sulphate, but on the admission of air, ferric hydrate soon forms."

The fact that the prevailing country-rock in the vicinity of the occurrences of bog-ore on Quatsino sound are granites and felsitic rocks, often heavily charged with iron pyrites, accounts for the rusty water, impregnated with decomposed pyrite, flowing down the hill-sides and leaving a thick scum on the rocks. This was considered an outcropping of iron ore and was responsible for many claims being staked, especially on the divide between Iron creek and Nahwitte river.

The occurrences that appear to possess commercial value are those exposed in many open-cuts on the group of mineral claims about a mile west from Coal harbour,

where the ore is generally quite clean and free from impurities, as is shown by the following analyses of average samples reported by Lindeman:

	Per Cent.	Per Cent.
" Insoluble matter	2.32	1.40
Iron	51.46	56.97
Sulphur	0.15	0.447
Phosphorus	0.008	0.008 "

All of the deposits of bog-ore are very irregular in outline, and vary in thickness with the variations of the surface of the ground, the greatest depth of ore being found in basins or depressions but as very little serious attempt to determine extent has been made, consequently, in the absence of proof of depth by drilling or sinking shafts, it is not possible to estimate tonnage available.

Owing to the fact that no work has been done on any of the claims since 1866 and 1867, and the conditions surrounding the old workings are such that no satisfactory information can be gained from an examination, the writer has incorporated in this report the one made by the Provincial Mineralogist, in the Minister of Mines' Report for 1867. His examination was made soon after shipments of the ore had been sent to the Irondale blast-furnace, and when the workings were fresh and in good condition for a thorough examination. The report is as follows:—

"*Quatsino Iron Ore.*—On arriving at the claims it was found that the company had acquired certain claims on the north side of the West arm, in Section 26 of the Quatsino Land District, as nearly as could be determined. The claims extend to the edge of the arm, and at a point about a quarter of a mile from the water a deposit of bog-iron ore of excellent quality had been discovered, covering the surface over a considerable area. To extract this ore, the Moore Investment Company had, earlier in the year, sent up a large force of men on an ore-barge, and had built a temporary wharf, from which a tramway was built to the iron-ore deposit. In August the property was found to have been abandoned, the track torn up, and the rails shipped away. From the workings visible it would appear that the iron-deposit over an area 300 feet long and 200 wide had been removed from the surface down to solid bed-rock, and this area had yielded 1,500 tons of ore, which had been shipped. The work done showed the deposit of bog-ore to be on a side-hill, which sloped at an angle of about 20 degrees towards the sea, lying on a smooth, water-worn bed-rock to a depth of, in some places, 4 feet, and in others, of as many inches; the average thickness of the deposit was not over 24 inches. Large trees and brush had been growing on top of the deposit, the roots being all through the ore, greatly increasing the cost of extraction, which, under the circumstances, must have been excessive. The superficial area over which the deposit shows is considerable, but no prospecting that has been done proves it to be of a greater average depth than at the point where its extraction was attempted.

"*Prince's Iron Claims.*—A few miles to the west, along the shore of the arm, a trail leads inland to the north for a couple of miles, to what is known as *Prince's Upper Claims*, a group of claims the number or names of which could not be ascertained. About two miles in on the trail two large cabins were found, and evidences that considerable work had been done, but no one was on the property when visited. The work had consisted of pits and open-cuts along the course of the valley of a small stream flowing into the arm. For the most part the pits were full of water and the materials taken out from them so mixed upon the dump as to be meaningless. The open-cuts were seen, however, and of these the one in which the most promising showing occurred started from the creek-bed and ran up the face of its gently sloping bank, showing in nearly horizontal layers, first, 4 feet of bog-iron ore; next, 1 foot of gravel with a layer of fine kaolin clay on top; next, 9 inches of iron ore, then 2 feet of ochre and clay, above which was the black surface mould. A similar showing was seen in another cut about 150 feet farther up the creek, and these may be taken as

typical of the more successful strippings made. There is, undoubtedly, a very considerable area covered with iron ore, but, so far as could be seen, its depth had not been demonstrated further than described. Samples were taken from the lower 4-foot deposit of ore, and upon assay gave 48.12 per cent.—48.31 per cent. and 50.19 per cent. of iron—with much organic matter. The ochre and clay stratum assayed 36.6 per cent. of iron.

"About three miles to the north-west from Prince's camp, claim to the number of about 100 had been staked during the summer by other parties. This wholesale staking had been done to blanket the district until the claims could be roughly projected, when those not wanted could be dropped—the land being held for one year at an outlay in fees of 5 cents an acre. This procedure, although contrary to the spirit of the 'Mineral Act,' was brought about by a tendency of certain local prospectors to stake 'extensions' to any claims that might be found by outside prospectors. No work other than staking had been done on any of these claims, and as they were from six to seven miles back from the lake, through wet brush, they were not visited."

The opportunity for cheap transportation is so favourable as to make these occurrences of bog-ore attractive, and should encourage more thorough prospecting, especially in the event of the development of the iron and steel industries on the Coast, because this ore is valuable to mix with magnetite in the blast-furnace.

UPPER QUINSAM LAKE.

Numerous large outcroppings of magnetite, occur on the north **Quinsam Lake** slope of a mountain about half a mile south from the south end of **Iron Syndicate**. Upper Quinsam lake, at elevations from 220 to 560 feet above the lake. These outcrops occupy a zone striking almost due east, and expose deposits that are representatives of the contact-metamorphic type, with magnetite lying between limestone and diorite, dipping 80 degrees north. The occurrences are found distributed within an area measuring about 1,000 feet wide north to south by 1,200 feet east to west, and while unbroken continuity is not shown between the various outcroppings on the surface, yet there are so many that it is almost excusable to consider them as belonging to one deposit until the contrary is proven.

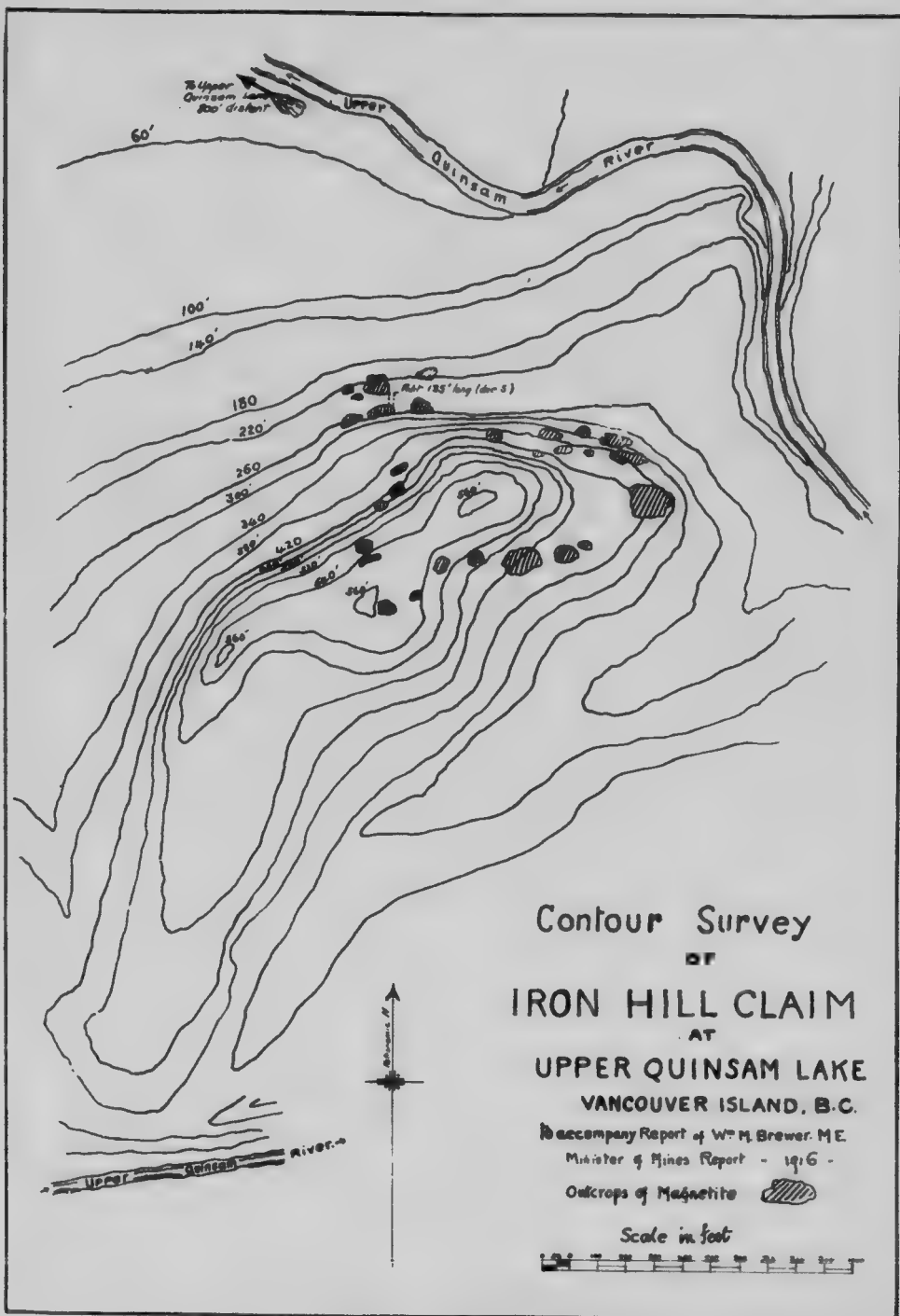
At 240 feet elevation above the lake there is an adit 135 feet long, driven into the mountain-side southward in magnetite the entire distance, and with magnetite in the face, but somewhat mixed with country-rock and garnetite. The side-hill rises at an average angle of 44 degrees, but over the face of the adit the slope is steeper, so that there are about 105 feet backs.

An average sample from the dump assayed: Iron, 58.6 per cent.; sulphur, trace; phosphorus, trace; silica, 9.3 per cent.

The adit is projected to cross cut the mineralized zone at the point where it is about 800 feet north to south. According to a topographic survey this adit is driven under several outcroppings of magnetite, and the projected face is 320 feet vertically under the farthest outcrop south of the portal.

Other work on the property consists of open-cuts and surface stripping to the east and south from the adit, and at various levels above the 240 or adit level, which openings expose a large number of outcroppings of clean magnetite. The most extensive occurs about 1,000 feet south-eastward from the adit on the 400-foot level; this measures about 100 feet across and is almost square.

It is impossible to form any reliable estimate of the tonnage of ore available from measurements made where work has been done because of insufficient data. There is no question but that a very large quantity of magnetite can be quarried for immediate shipment. The contour of the mountain-side is such that the ore can be mined with steam-shovels, in a manner similar to that in use in the low-grade



copper-ore mines in Utah, and the large quantity of ore exposed in surface outcroppings alone is evidently sufficient to suggest this method for mining operations.

In the floor of the adit on the 240-foot level the ore-body is quite as strong as on the surface, and there is every indication that it maintains its continuity to an undetermined depth below this level.

TEXADA ISLAND.

The property owned by the Puget Sound Iron Company is on the west coast of Texada Island; it extends from Gillies bay north-westward along the coast three miles and a half, and contains 3,004 acres of Crown-granted land. The original locations that make up the portion known as the "Iron Mines" comprise about 1,000 acres at the north-west end of the property, included in which are the three quarter-sections for which Crown grants were issued in 1874 by Lieutenant-Governor Joseph William Trutch to Henry William Hughes, Harry Trim, and Josias Charles Hughes. The Puget Sound Company, after acquiring these Crown-granted quarter-sections, had mineral locations staked over them in order to secure the precious metals as well as the base, and these locations have since been also Crown-granted. The most important occurrences of magnetite occur on the quarter-sections mentioned; they are named the *Prescott*, *Paxton*, and *Lake* mines, and belong to the contact-metamorphic type of deposits.

This mine is near the extreme south-western corner of the range of limestone hills that extend across Texada Island from Sturt bay, on the north coast, to the iron-mines within about half a mile from the south coast, where the limestone contacts with igneous rocks, with porphyrite on the east, quartz diorite on the south, and porphyrite on the west. Lenticular masses of magnetite from 200 to 300 feet long occur at the contacts. The apparent continuity of the magnetite has been shown to a vertical depth of 670 feet below the highest outcrop to the northward at 820 feet elevation, with the ore showing 80 feet wide in the floor of the adit, 150 feet above sea-level, and the ore in solid magnetite. The magnetite outcroppings occur on the steep slope elevations from 200 to 820 feet above sea-level, with those above the third 520 feet occurring almost directly north from the mine-workings on the *Prescott* body and within a distance of 1,000 feet. The area in which the outcrops are enclosed measures about 1,500 feet north to south by about 1,000 feet east to west. The mine-workings are on four levels above the adit, at 150 feet elevation. These are called: Shaft level at 290 feet elevation; first level at 365 feet; second level at 405 feet; third level at 520 feet. The adit, which is 700 feet long, intersects the bottom of the shaft 475 feet from the portal. It is then driven northward through quartz diorite 380 feet, where a mineralized vein 4 feet wide is crosscut; the minerals in this vein are marcasite, iron pyrites, and some chalcopyrite. It strikes north-west and dips 54 degrees southward. After crossing this vein the adit is continued through quartz diorite to 600 feet from the portal, where the quartz diorite contacts with garnetite mixed with magnetite; this is crosscut for about 20 feet, then solid magnetite is exposed and crosscut 80 feet to the face, which is still in magnetite. An average sample across the face of this adit assayed: Iron, 66 per cent.; sulphur, nil; phosphorus, trace; silica, 3.3 per cent.

The shaft is 140 feet deep, sunk from 200 feet elevation, but as this was sunk in 1890 for prospecting and has never been used as a working opening, the ladders were in an unsafe condition and no examination could be made. The record of the work kept by W. H. Lee, the superintendent, shows that the shaft from the collar to about 70 feet deep passed through magnetite mixed with iron pyrites and some chalcopyrite in a garnetite, epidote gangue; then through quartz diorite to the bottom. A sample from the outcrop in which the shaft is sunk assayed: Gold,

trace; silver, 9.3 oz.; copper, 1 per cent. This sample was not assayed for iron. Another sample from the dump at the collar of the shaft taken for the purpose of showing the copper content assayed: Gold, trace; silver, 1.6 oz.; copper, 6.2 per cent.; iron, 26.2 per cent.

On the first level there is an open-cut, the dimensions of which are 60 feet long on the strike by about 30 feet wide by 35 feet high at the face. This cut exposes a solid body of magnetite associated with some little chalcopyrite and iron pyrites in a garnetite gangue. A considerable proportion of this ore will carry about 1.5 per cent. copper content, and in places could be sorted up to about 3 per cent. copper.

The second level is opened 40 feet above the first and a short distance west of a straight line up the hill, where there is an occurrence of magnetite about 300 feet long by 80 feet wide. The workings are an open-cut 60 feet north to south and 30 feet east to west, with its face nearly 100 feet wide, and an adit driven northward from the open-cut 22 feet long in magnetite. This level is connected with tide-water by a gravity-tramway that was used some years ago when active mining was being done. Several thousand tons of magnetite was shipped to the Irondale blast-furnace for making pig-iron, and the portion of the ore with copper content was sorted out and shipped to some of the copper-smelters on the Coast for fluxing material.

Average samples of magnetite from the second level assay:—

	Lindeman's Sample.	McConnell's Sample.
" Iron	64.30 per cent.	62.57 per cent.
Sulphur	0.303 "	0.403 "
Phosphorus	Not determined.	0.024 "
Insoluble matter	Not determined.	6.46 "
Copper	0.14 per cent.	Not determined."

A shipment of 600 tons of magnetite made about 1885 to the Irondale blast-furnace assayed: Iron, 65.7 per cent.; phosphorus, 0.083 per cent.

The third level is opened at 520 feet elevation by a large open-cut made in magnetite, which shows much less copper and iron sulphides mixed with the magnetite than on either the first or second levels, and is of superior quality for iron-making. This open-cut is made along the strike of the ore; it is 50 feet wide by 100 feet long by 50 feet high at the face. This lens of magnetite on the surface is apparently about 300 feet long, or about the same length as on the second level.

Garnet, hornblende, epidote, and calcite are the non-metallic impurities that occur with the ore on all the levels in varying quantities, these minerals are usually found at and near the boundaries of the occurrences of magnetite, and less frequently in the interior of the mass or lens.

Higher up the mountain, northward from the third level, other large outcroppings of magnetite occur. Two of these are at 640 feet elevation and are in the same contact as the main mass lower down the slope. The third occurrence is at 820 feet elevation and has formed entirely in limestone; it appears to be separated from the main ore-body by a mass of coarse crystalline limestone, in which a number of apparently small irregular lenses of magnetite occur.

There are also outcroppings of magnetite west from the main workings on the Prescott mine, along the limestone-diorite and limestone-porphyrite contacts, on which no work has been done.

This mine is about 3,300 feet eastward from the Prescott, and **Paxton.** the line of the limestone-diorite contact is traceable between the two mines, but very irregular. The diorite gives place to porphyrite near the west boundary of the Paxton ore-body, which, though, occurs in the quartz diorite near its contact with porphyrite, and very near the limestone, but not in the immediate contact.

The Paxton mine has been developed by open-cuts and short adits on about the same level as the collar of the shaft on the Prescott at 290 feet elevation. The

open-cuts show the dimensions of the occurrence of magnetite to be about 300 feet long by about 150 feet wide by about 100 feet high above the floor.

The ore-body outcrops on a steep slope about 100 feet high, the lower part of which is diorite and the upper part magnetite. The face of the slope has been stripped 220 feet from east to west, and open-cuts and adits have been driven northward from near both ends of the stripping. The easterly open-cut is about 100 feet from the east end, and is 36 feet long, serving as an approach to an adit 40 feet long. The open-cut is made through quartz diorite for 18 feet, where the contact with magnetite is exposed and the remainder of the open-cut, as well as the adit, is in solid magnetite. The westerly open-cut is 37 feet from the west end of the stripping and 83 feet from the other open-cut. This cut is driven 32 feet as an approach to a short adit. Of the 32 feet, 20 feet are through quartz diorite to the contact with magnetite, and the remainder, as well as the short adit, through magnetite. The faces of both adits are in solid magnetite, so that the width of ore is undetermined. The dip of the diorite-magnetite contact is nearly vertical, and the strike of the magnetite lens is eastward.

The quantity of sulphides, mostly iron pyrites, is greater in the *Paxton* ore than in the other bodies. A sample taken along the adit by McConnell, assayed: "Iron, 59.40 per cent.; copper, 0.30 per cent.; sulphur, 1.07 per cent."

A sample taken by Landeman from the same adit assayed: "Iron, 64.48 per cent.; sulphur, 1.866 per cent.; phosphorus, 0.005 per cent.; silica, 4.47 per cent.; copper, 0.22 per cent.; magnesia, 1.13 per cent.; lime, 1.32 per cent.; alumina, 0.66 per cent."

The third important occurrence of magnetite on the property of the Puget Sound Iron Company is known as the *Lake* mine, and is 1,300 feet east from the *Paxton*. The occurrence of magnetite lies in a bluff about 80 feet high at the contact between limestone and porphyrite, with porphyrite on three sides and with a body of garnetite and epidote on the north side separating the magnetite and limestone. The strike is east and dip nearly vertical. The mass of magnetite measures about 300 feet in length, with an average width of about 130 feet. It has been developed by an open-cut 100 feet long from east to west by 60 feet wide and about 80 feet high at the face. The magnetite in the *Lake* deposit is finer grained than in the other large masses, and freer from iron and copper sulphides. A grab sample taken from the dump assayed: Iron, 58.0 per cent.; sulphur, 1.6 per cent.; phosphorus, trace; silica, 0.5 per cent.

McConnell reports that a rough general sample taken from the faced magnetite cliff, and assayed in the laboratory of the Canadian Mines Branch, yielded: "Iron, 57.50 per cent.; copper, trace; sulphur, 0.046 per cent."

Landeman reports an average sample from the *Lake* mine assaying: "Iron, 59.57 per cent.; sulphur, 0.137 per cent.; phosphorus, 0.057 per cent.; silica, 8.33 per cent.; copper, 0.08 per cent.; alumina, 1.71 per cent.; lime, 3.82 per cent.; magnesia, 1.05 per cent."

There are several lenses of magnetite on the property of the Puget Sound Iron Company in addition to those on which development-work has been done, but while some of the occurrences are of considerable extent as shown by the surface outcroppings, no attempt has been made to prospect them. South from the *Lake* mine there is a line of narrow magnetite lenses within about 1,000 feet, all of which occur in porphyrite at considerable distances from limestone and diorite contacts. The longest of these is 220 feet, with a width varying from 10 to 20 feet. Two other lenses measure respectively 54 and 50 feet in length, with widths from 10 to 20 feet. The other lenses along this line are smaller.

The magnetite in all of these occurrences is very pure, and an assay of a sample from the longest lens is reported by McConnell as yielding: "Iron, 60.40 per cent.; copper, none; sulphur, 0.01 per cent."

It is impossible to estimate with any degree of accuracy the tonnage of magnetite in the several masses that occur on the property, because the development-work has been done with a view of mining and shipping ore rather than for measuring the available tonnage, and no underground work has been done except on the *Prescott* mine.

Regarding tonnage, McConnell, in his report on Texada Island in Memoir 58, Department of Mines, Canada, page 88, says as follows: "For the purpose of making a rough estimate, it is assumed that the lenses extend downwards for a distance equal to their exposed surface length. The *Prescott* ore-body with a surface length of 300 feet has been proven to extend downwards for a distance of 430 feet, and at the lower level is still strong and must descend considerably farther. The tonnage in the main *Prescott* ore-body above the lower tunnel is estimated at 1,300,400 tons. The three large lenses in the limestones north-eastward from the *Prescott*, assuming that they persist to a depth equal to their surface length, would yield 903,000 tons. The *Parson* ore-body yields 1,007,200 tons and the *Lake* ore-body 704,000 tons. The total tonnage in the six ore-bodies, estimated on the basis adopted, amounts to 4,521,200 tons.

"No account is taken in this estimate of the numerous small lenses from 20 to 100 feet or more in length occurring along the range. Some of these are surrounded by large areas of intense alteration and mineralization, and the concealed portions may be much larger than the small outcrops appear to indicate.

"It is also unlikely that the lenses cut by the present surface represent the lowest tier formed. It is more probable that they are followed in depth along the contacts by other lenses, and the tonnage given above may be multiplied several times before the iron resources of the district are exhausted."

KLAANCH RIVER.

The *Klaanch* river flows from the south-east into *Nimkish* lake at the south end; the lake empties into *Broughton* strait opposite *Alert* bay through the *Nimkish* river, about 180 miles north-westward from the city of *Vancouver*. The *Iron Crown* mineral claim is the most important of a group of claims owned by *Adam Mathers*, of *Alert* bay, and is situated about seven miles up the *Klaanch* on the south side of the ri-

Practically but little development has been done since an examination was made by *Einar Lindeman* in 1907, when he made a magnetic survey and map, which accompanies his report in Bulletin 47, Mines Branch, Department of Mines, Canada, page 19. For this reason the writer did not visit this property, as the time at his disposal was limited. *Lindeman's* report is as follows: -

"The claim of most interest is, however, the *Iron Crown* mineral claim. An exposure of magnetite extends along the face of the river-bank for some 180 feet. The height of the bank is about 80 or 100 feet, forming at some points cliffs of magnetite 25 to 30 feet high. A sample of the ore gave the following analysis: Insoluble matter, 4.12 per cent.; iron, 64.23 per cent.; sulphur, 0.233 per cent.; phosphorus, 0.010 per cent.

"Farther up the hill, about 250 feet from the river, several outcrops of magnetite occur along the ridge. An average sample from these gave the following analysis: Silica, 5.30 per cent.; iron, 63.89 per cent.; alumina, 1.74 per cent.; lime, 0.80 per cent.; magnesia, 1.86 per cent.; copper, trace; sulphur, 0.017 per cent.; phosphorus, 0.037 per cent. The solid formation being effectively covered by a sandy loam and a heavy vegetation, the outcrops mentioned were all that could be seen, but the dip-needle showed a very strong magnetic attraction in several places, it was found advisable to make a magnetic survey and get some information in regard to the extent of the ore-bodies. The topography of the ground, the heavy vegetation, and the great number of windfalls delayed this investigation very much.

In the magnetometer the vertical force of the normal terrestrial field is counter-balanced beforehand by a small weight on the arm of the needle. Through the swinging of the needle in a plane, as above mentioned, the horizontal intensity of the earth's normal magnetic field and the horizontal component of the magnetic force of the ore-body become annulled, and the vertical component of the magnetic force of the ore-body is, therefore, the only magnetic force which affects the needle, and, according to its strength in the different places, causes the different readings marked on the map. The places which have positive magnetic intensity—i.e., when the north pole of the magnetic needle points below the horizontal plane—are marked blue, and, on the other hand, the places where negative magnetic intensity—i.e., where the south pole of the needle points below the horizontal plane—are marked yellow on the map.

"To avoid misunderstanding by any person who is not familiar with magnetic maps of this kind, I desire to point out that all the area coloured blue cannot be considered to be underlain by magnetite, but only a certain part of it. Further development-work will find the magnetite underneath the places with the highest positive readings, and north of them for a short distance down the hill, and here outcrops of magnetite were and will be found where strong negative readings were observed. This fact is due to the topography of the ground, the instrument being set up below the upper pole of the ore-body. This attracts the north pole of the magnetic needle and causes the negative reading. The map shows three separate deposits or groups of deposits, which for reference have been numbered I., II., and III.

No. I. outcrops on the river-bank, as before stated. The top of the bank is covered with soil, and no work has been done to ascertain the width of the deposit; but, to judge from the magnetic curves and outcrops available, the width at the west end may be estimated at not less than 100 feet. The length of the ore-body may be assumed to be about 190 feet.

"Group II. is the most important and may be assumed to consist of two, possibly three, ore-lenses, not counting the small pockets in the southern part of the group. The largest of these ore-lenses has a length of at least 380 feet; a width of 60 feet is very probable, and in some places it is even greater.

"Group III. is altogether covered by soil. The magnetic curves show, however, the ore strikes to be about parallel with the former group, with a length of about 480 feet, and a width which, in places, may be assumed to be very little less than that of the former. In regard to the depth of the different ore-lenses, no conclusion can be drawn from the magnetic map; but as far as surface indications go the claim may be said to be one of the best iron prospects on Vancouver Island, and well worth further development."

Haematite and Limonite.

In connection with the foregoing description of the occurrences of magnetite on Vancouver and Texada Islands, it is considered advisable to publish the report by J. D. Galloway, Assistant Mineralogist, on the occurrence of haematite-iron ore on a branch of the Klinaklini river, in the Nanaimo Mining Division, also a report by J. D. MacKenzie, in the Summary Report for 1915 of the Geological Survey Branch, Department of Mines, on the occurrence of bog-iron ore on a branch of the Zymoetz river, in the Skeena Mining Division.

WALLACE IRON SHOWINGS ON KLINAKLINI RIVER.

INTRODUCTORY.

A deposit of haematite on a branch of the Klinaklini river, and therefore in the Nanaimo Mining Division, was staked a few years ago by Sam Colwell. Later his holdings were acquired by the Haematite Mining Company, the control of which is held by Peter Wallace and associates, of Vancouver. The property comprises thirteen claims, which are surveyed but not yet Crown-granted. Development-work has been carried on during each summer since the claims were staked; this work consists of open-cuts and a 600-foot tunnel. Mr. Morris, who is interested in the company, has been in charge of this work, subject to instructions from the Vancouver office.

LOCATION.

The Klinaklini river has its source in the Coast range, rising in three separate branches which come together; from the junction the river is about fifty miles in length, finally flowing into Knight inlet. The iron claims owned by the Haematite Mining Company are situated on the head-waters of the most westerly of these branches. They are situated at the head of Chromium creek and at the base of and on the west side of a prominent pyramid-shaped mountain named Perkins peak; this is one of the highest peaks in this section of the Coast range, reaching to an elevation of 9,500 feet above sea-level. The claims are all well above timber-line and are so staked as to take in the rocky glacial cirque at the head of Chromium creek, and extending up the sloping side of Perkins peak.

The showings of iron ore are situated on the *Britton* and *Monarch* claims at the foot of the mountain, where the slope is not great. A short distance above the showings the mountain rises steeply and in places forms nearly perpendicular bluffs. The surface where the iron-outcrops were discovered is for the most part covered with talus material from the bluffs above. This talus consists of sharp jagged rocks of all sizes, the depth varying from 1 foot up to probably 20 feet.

GEOLOGY.

GENERAL.

This district is situated in the zone of the eastern contact of the Coast range with the older sediments and volcanics. The Coast Range rocks here as usual consist mainly of granite, diorite, and granodiorite. The older rocks, into which these plutonics are intrusive, are quartzites and argillites, together with interbedded volcanic flows consisting of andesite, basalt, diabase, and porphyritic rocks. These

older rocks all show the effects of profound regional and dynamic metamorphism, which has probably been mainly caused by the thermal and dynamic action of the intrusive Coast Range batholithic rocks.

The older metamorphic rocks now occur as patches and large inclusions surrounded by the batholithic rocks, and are deeply cut by dykes which are apophysal phases of the plutonic magmas. The contact-zone is an irregular area which is variable in width and gradually changes, going easterly, to where the older rocks predominate, with only a few dykes of the younger plutonic rocks cutting them. Still further east these older rocks are capped by volcanic flows of Tertiary age, which are mainly of a basaltic nature.

DETAIL.

This deposit of hematite is of contact-metamorphic origin. The ore is developed in an argillitic rock generally at points not far distant from where pegmatitic granitic dykes cut the argillites. As is usual in this character of an ore-body, the occurrences of ore are irregular, but further development may prove that the different outcrops are more continuous than they now appear to be. As the surface is covered with slide-rock, the iron ore is only exposed here and there in trenches and cuts. As far as can be seen, it would appear as if the argillite occurred as small lenses engulfed in a granitic magma and cut by dykes of granitic rock. Towards the end of the granitic intrusion iron-bearing solutions followed along the dykes and attacked and dissolved out the argillite, metasomatically replacing it with iron oxide. In places this iron oxide—hematite—is solid, and in others it fades gradually away to straight argillite. The hematite is of the hard variety, the colour being a very dark red to almost black.

The granitic dyke-rock is characterized by being very completely altered from its original condition; it now consists of kaolin, chlorite, with some quartz and mica crystals. The large amount of kaolin present, formed from alteration of original feldspar, makes the rock quite soft.

DESCRIPTION OF THE WORKINGS.

The main showings of iron are situated on the *Britton* and *Monarch* claims. The surface work consists of eight open-cuts, with a depth of 4 or 5 feet and a length of from 10 to 50 feet. These openings are mainly in slide-rock, and, as most of them were made two years ago, the sides of the cuts in many places have fallen in, thus making it difficult to examine the bottom. The most westerly cut shows a width of 6 feet of nearly solid hematite. A sample cut across this 6 feet returned the following assay:

Iron	47.6 per cent.
Sulphur	Nil.
Phosphorus	Trace.

Another sample taken to be an average of the dump from this cut assayed:—

Iron	48.4 per cent.
Sulphur	Nil.
Phosphorus	Trace.

There are several cuts exposing ore which are stretched along the route of the tunnel. None of these cuts show any great width or length of ore, and in most of them it is doubtful if the bottom shows rock in-place. All the dumps from these cuts show hematite mixed with argillite and granitic rock. A sample of selected ore from one of these dumps assayed:—

Iron	57.0 per cent.
Sulphur	Trace.
Phosphorus	Trace.

Besides the open-cuts, the main development has been by means of a tunnel 600 feet long. This tunnel shows practically no iron ore, with the exception of a little near the portal, which is, however, of a poor grade and much inferior to that seen in the surface cuts.

At a point 40 feet in the tunnel there is a winze down 18 feet following an irregular contact between argillite and granite, but, contrary to expectations, no hematite of commercial grade was found. The tunnel continues through granitic rock for some distance, when another band of argillite was encountered and crossed through. Beyond this the tunnel continues through 200 to 300 feet of granite to where a schistose rock was encountered. The tunnel was continued on into this schistose rock for some distance, and this is the rock at the face of the tunnel. This schist carries a considerable percentage of iron pyrites.

It is unfortunate that so much work was done in this tunnel without producing any material results in the way of proving the property. In the opinion of the writer, some further development of the iron showings on the surface would have given better information as to how the lenses of ore occur, and, with more complete information as to dips and strikes, the tunnel could probably have been driven to better advantage. With several open-cuts showing iron ore on the surface along the route of the tunnel, it would be reasonable to suppose that, had these lenses of iron ore any great downward extension and a real development, iron ore would have been exposed in the tunnel.

CONCLUSION.

This deposit of iron ore is as yet an undeveloped prospect, without much proved for or against it. There is no possibility of estimating, at the present time, any appreciable tonnage of reasonably assured ore, or even of probable ore. At no place is there more than a few tons of ore proved up. It is possible, however, that further development would reveal a continuity between the different outcrops and so show a considerable tonnage of ore.

The geographical situation of the property is such that the property, even with a large tonnage of ore proved, would be only of potential value. Iron ore could only be taken to a possible market by means of rail transportation. With this iron-deposit a very large tonnage would have to be proved before it would be worth while building a railroad for the hauling of the ore. It is, of course, possible that in the future a railway may be built to develop the natural resources of this section and in that case transportation would be provided for any deposit of iron ore.

LIMONITE (BOG) ORE DEPOSITS IN THE SKEENA MINING DIVISION.

The following is the report of J. D. MacKenzie:—

"The bog-iron ore property owned by the North Pacific Iron Mines, Limited, of Prince Rupert, is situated on Limonite (Summit) creek, a tributary of the Zymoetz (Copper) river, thirty-eight miles east of Copper City, on the Skeena. It is six miles west of the summit of the Zymoetz River-Telkwa River trail and about forty miles from Telkwa. The property consists of nine claims on the north side of the creek, covering approximately 375 acres.

"The largest of the deposits on the property, shown in the accompanying sketch-map, was examined by the writer and is described below. He was later informed on good authority, however, that other, smaller, similar deposits occur at higher elevations on the mountain-side, farther back from the creek, but these were not visited by him.

"The deposit examined, which consists of a sheet of bog-iron ore of unknown thickness, extending from the 'moss-roots' to bed-rock, lies on the steep north side of Limonite Creek valley. It extends from the stream itself for a distance of 1,800 feet in a straight line up the mountain-side, which rises steeply from an elevation of 2,000 feet at the stream to 3,500 feet at the upper edge of the bog-iron ore. The irregular area underlain by the limonite measures about 2,250,000 square feet (50 acres), and its greatest width is about 1,800 feet.

"Everywhere in this area, yellow or brown earthy limonite may be uncovered merely by removing the moss from the surface; there is no overburden except the trees and moss growing on the limonite beneath, and this vegetation has been removed by burning in two places, leaving large areas of the ore exposed.

"The deposit consists of bedded bog-iron ore, occurring in platy layers from 1 to 3 inches thick, lying parallel to the hillside, which here has an average slope of nearly 30 degrees. In addition to the stripping of the ore by burning, prospecting has been done by trenching and sinking numerous pits. The greatest thickness of limonite anywhere exposed is 15 feet; in two or three places 10 feet is exposed, and several cuts show 3 to 4 feet. In no place has the bottom of the sheet of ore been reached, and as no systematic attempt has been made to determine the quantity of ore present it is difficult to form any estimate of the amount available.

"The ore consists of yellow and brown earthy limonite, free from sandstone or other impurities, rather soft and of a loose consistency, so that it may readily be dug with a pick or cut with an axe. The ore extracted from the large open-cuts has disintegrated on weathering to a crumbly, in part pulverulent mass, ranging in size of from a grain of powder to fragments an inch or two across. It is thoroughly saturated with water as it lies in the bed, but when dried might run about 20 cubic feet to the ton, at a guess.

"If the surface area be taken at 2,250,000 square feet, this figure would give 112,500 tons per foot of depth. An average depth of 5 feet for the deposit is almost certain; 10 feet is probable and perhaps the depth is greater. In other terms, 562,500 tons may be considered as almost certainly proven; twice that as probable, and perhaps the amount is considerably larger. Analyses of the ore are given below:—

"ANALYSES OF ORE FROM NORTH PACIFIC IRON MINES, LTD.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
Iron (metallic)	54.20	56.01	54.32	52.19	51.0	50.6	53.2	53.2	54.0
Silica (SiO ₂)	1.02	0.83	1.99	1.56	2.0	1.7	1.31	1.62	1.04
Manganese (Mn)	0.85	0.51	0.30	0.70	..	..	..	..	..
Phosphorus (P)	0.407	0.016	0.065	0.616	None	None	0.0016	0.014	0.002
Sulphur (S)	1.16	1.52	1.14	1.47	1.7	0.8	2.65	1.89	1.15
Water, combined	18.54	16.02	20.47	19.61	..	..	..	..	..

Analyses 1 to 4 were made by H. A. Leverin, Mines Branch, from samples collected by J. D. MacKenzie.

1. Sample of a trench wall, from 2 feet to 10 feet below the surface. Taken by cutting a groove 1 foot wide, 6 inches deep, 8 feet long, and quartering to 8 lb.

2. A picked specimen representing a 12-inch, harder, more compact band about 2 feet below the surface at the locality of No. 1, and also found in several other places in the deposit.

3. Sample of dump thrown out of a cut made in the deposit on a steep hillside; the cut is 2 to 3 feet wide, with a level bottom 40 feet long and a 20-foot face, exposing 15 feet of platy bedded ore lying on the hillside.

4. Sample of the dump from a trench 2 feet wide, 3 feet deep, and 50 feet long.

(These four analyses were made on material finely ground and dried at 104°C. until all hygroscopic moisture had been expelled.)

5. Sample taken at a depth of 15 feet from the surface (doubtless from the cut represented by analysis 3). Collector, W. M. Brewer.

6. Sample sent to British Columbia Bureau of Mines by the owner. (Analyses 5 and 6 by the Analyst of the British Columbia Bureau of Mines.)

7, 8, and 9. Analyses by Falkenburg and Laucks, of Seattle.

"These analyses, on samples taken in different ways and by different men, and made by at least three different analysts, agree very well, and emphasize the homogeneity and purity of the bog-iron ore.

"The country-rock on which the ore lies is an altered, greenish porphyry, containing in many places impregnations of pyrite. Across the valley of Limonite creek to the south this porphyry is in contact with quartz diorites of the Coast Range rocks, which are probably intrusive into it. The writer is informed that on the mountain-side above and to the north of the iron-deposit are many quartz veins carrying pyrite.

"The deposit lies on the western slope of the high eastern ridges of the Coast range, and the rainfall in this district, to judge by the vegetation, is very much in excess of that only a few miles to the east. At any rate, moisture is abundant throughout most of the year, and water is constantly flowing down the hillside under the moss. The water flowing over the iron-deposit has a strong taste of iron salts, and plainly has been derived from the decomposition of iron sulphides farther up the mountain-side. This strong solution of iron sulphates trickling down under the moss has built up the deposit as it now stands by the progressive transformation to limonite of successive layers of moss and other vegetation from beneath. That the efficacy of this process is undoubted is borne witness to by the limonitized twigs, roots, chips, fir-needles, and cones that have been transformed partly or wholly to limonite in the few years since the burned areas were cleared. In several places beautiful stalactitic terraced accumulations of limonite have been built up, which are even now in rapid process of growth.

"The iron ore is excellently situated for mining, provided transportation could be obtained. There is ample hemlock and balsam fir timber in the vicinity, and Limonite creek, with its fall of 400 feet in the first mile of its course from the lakes at its head, would furnish sufficient power for a considerable plant, at all seasons, as the water could be readily impounded in storage reservoirs."

During the summer of 1914 the writer (Wm. M. Brewer) examined the group of mineral claims owned by the North Pacific Iron Mines, Limited, described in MacKenzie's report herein quoted. His report was published in the Minister of Mines' Report for 1914. It is not necessary to reproduce it in this bulletin, because MacKenzie's report shows that he was enabled to devote more time to the examination and cover the ground more thoroughly than the writer (Wm. M. Brewer), who had no guide conversant with the property to assist him in his examination.

The following remarks relative to transportation facilities and other iron-ore prospects are copied from the writer's (Wm. M. Brewer) old report, as they are equally applicable to the conditions prevailing in 1917:—

"At the present time this property is handicapped by the lack of transportation, but the Grand Trunk Pacific Railway Company has had a preliminary survey made, and from that data the length of this railroad from the property to Copper City, on the main line of the Grand Trunk Pacific Railway, would be about sixty miles. The writer was informed by C. C. van Arsdol, chief engineer of the Grand Trunk Pacific Railway Company, that it was perfectly feasible to construct a railroad through this portion of the country via the Zymoetz River route for local freight-haulage, but that there were difficulties to be surmounted which made it inadvisable to incorporate that section in a transcontinental route.

The property is very favourably situated with regard to timber for mining, fuel, and a fair supply for lumber, the varieties being of hemlock and balsam, as well as some cedar. The water-supply furnished by Summit creek would be ample for all purposes, even to developing power for a plant of considerable magnitude.

Mansel Clarke, the discoverer and locator of this property, informed the writer (Wm. M. Brewer) that he had found other outcroppings of both magnetite and limonite iron ore for a distance of about nine miles in a N. 75° E. direction, or on the extreme summit at the headwaters of the Telkwa river, but could not find any deposits that would begin to approach in extent the body on the group of mineral claims examined."

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